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Revision 4

Feed Composition for the Sodium-Bearing Waste Treatment Process

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ABSTRACT

A settlement agreement between the State of Idaho and the United States Department of Energy mandates that all sodium-bearing waste at the Idaho Nuclear Technology and Engineering Center, within the Idaho National Engineering and Environmental Laboratory, be treated by December 31, 2012. Detailed feed compositions are needed to design a facility to treat this waste. This report presents the expected volumes and compositions of these feed streams and the sources and assumptions used in determining them.

SUMMARY

A sodium-bearing waste (SBW) treatment facility will treat liquids and solids contained in existing tanks at the Idaho Nuclear Technology and Engineering Center (INTEC). The treatment facility will also treat additional liquid waste, called newly generated liquid waste (NGLW) that will be generated after 2005 and stored in separate tanks from the SBW.

This report presents the most recent compilation of volumes and compositions of the feed streams to the treatment processes. This report also identifies the assumptions and source documents used in calculating the treatment process feed compositions and the uncertainties in these compositions. Feeds to the treatment process will include SBW from Tanks WM-187, WM-188, and WM-189, and NGLW from Tanks WM-100, WM-101, and WM-102.

Tank WM-189 presently contains waste near its administrative capacity and no additions to this tank are expected. As of June 1, 2004, Tank WM-188 contained about 259,000 gallons of waste. Approximately 26,000 gallons of additional waste will be added to Tank WM-188 by the end of FY 2005. The composition presented in this report for waste in Tank WM-189 is based on sample analyses. The projected composition of waste in Tank WM-188 (when full) is based on analyses of a sample taken when the tank was approximately 75% full, analyses of wastes added to the tank since that time and estimated compositions of wastes that will be added to the tank.

Tank WM-187 presently contains heels that have been flushed from six other Tank Farm Facility (TFF) tanks. The dilute liquid waste in the tank is presently being evaporated to make room for concentrated waste from Tank WM-180. Transfers in and out of Tank WM-187 are expected to be complete by the end of FY 2005. A projected composition of the final waste in WM-187 is contained in this report, and is based on compositions of the different wastes that make up the final tank contents. Because of the tank heels collected in Tank WM-187, this tank has the highest undissolved solids content of any of the tanks.

Based on projections of the volumes of NGLW streams generated between now and the end of 2012, a composition of the total NGLW as of 2012 has been calculated and is presented in this report. For some NGLW streams, chemical composition data are available and have been used in generating the treatment facility feed composition. However, data for radionuclide concentrations in NGLW are extremely limited. Thus, radionuclide concentrations in NGLW are based on data for SBW. Starting in FY 2006, NGLW will be collected in tanks WM-100, WM-101, and WM-102.

Supplemental feed characterization data presented in this report includes liquid and solids properties, analysis data for past tank solids samples, estimates of uncertainties in tank compositions, and concentrations of organic species in SBW.

Analyses have been performed on 11 samples of tank solids from eight TFF tanks. These analyses provide data of both the chemical and physical properties of the solids. Tank solids have been found to be largely amorphous and contain high concentrations of Si, P, Zr, O, and Al. Equipment limitations have prevented obtaining a well-mixed sample of solids in Tank WM-187. Analysis data of solids from Tank WM-187 reflects this fact and suggests that compositional changes may occur during transfer of solids from one tank to another.

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TABLES

ACRONYMS

CMACT	Calcination with MACT upgrade SBW treatment alternative
DEA	diethanolamine
EDF	engineering design file
ETS	Evaporator Tank System (formerly the High-Level Liquid Waste Evaporator)
ICPP	Idaho Chemical Processing Plant
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
LDUA	light-duty utility arm
LET&D	Liquid Effluent Treatment and Disposal (facility)
MACT	maximum achievable control technology
NGLW	newly generated liquid waste
NWCF	New Waste Calcining Facility
PEW	process equipment waste
PEWE	Process Equipment Waste Evaporator
PSD	particle size distribution
RCRA	Resource Conservation and Recovery Act
SBW	sodium-bearing waste
SG	specific gravity
SVOCs	semi-volatile organic compounds
TEA	triethanolamine
TFF	Tank Farm Facility
TIC	total inorganic carbon
TOC	total organic carbon
TRU	transuranic
UDS	undissolved solids
VOCs	volatile organic compounds
WCF	Waste Calcining Facility
WIR	Waste Incidental to Reprocessing

GLOSSARY

Alternative: A holistic solution for sodium-bearing waste (SBW) treatment, including the process/technologies used, and in the larger context, the program/project and its cost, schedule, and regulatory and stakeholder environment.

Calcine/MACT or "CMACT": An SBW treatment alternative that includes upgrades to the calciner in the NWCF, a new Maximum Achievable Control Technology (MACT) compliance facility, a scrub treatment process, and possibly a new calcine packaging facility.

CsIX or Cesium Ion Exchange/TRU Grout: An SBW treatment alternative that includes filtration of solids, cesium removal by ion exchange and one of several possible methods for stabilization of the cesium-free contact-handled transuranic (TRU) waste, namely, grouting, absorption on silica gel or absorption on another sorbent. The baseline process is grouting and the name would change if another stabilization method were chosen.

Direct Evaporation: An SBW treatment alternative involving concentration of SBW by evaporation to the extent that it solidifies upon cooling into a disposable waste.

Heels: The initial residual volume left in the Tank Farm tanks consisting of concentrated SBW liquid and tank solids after removal of the liquid waste by existing steam jets.

Newly Generated Liquid Waste: Liquid waste from a variety of sources that in the past has been evaporated and added to the liquid waste in the below-grade tanks at INTEC. Sources include leachates from treating contaminated high efficiency particulate air filters, decontamination liquids from INTEC operations that may or may not be associated with INTEC waste management activities, and liquid wastes from other INEEL facilities. INTEC has historically used this term to refer to liquid waste streams (past and future) that were not part of spent fuel reprocessing. NGLW will be stored along with SBW in the TFF tanks until September 2005 whereupon present plans call for its segregated storage. Since it is mixed with the existing SBW in the TFF tanks it does not formally exist as a separate entity and will not until segregation starts in 2005.

Sludge: The mixture of tank solids and interstitial liquid.

Sodium-bearing waste: The term is non-specific and can range in meaning from SBW liquid minus tank solids to all Tank Farm tank contents (SBW liquid and all tank solids). SBW is mixed hazardous, radioactive waste generated as a by-product of spent nuclear fuel reprocessing. It consists in minor part of second and third cycle extraction wastes but is mostly made up of decontamination solutions used over the years in support of operations. It is relatively high in sodium and potassium content from the solutions used for decontamination. Hence the name, SBW, and its separate tracking and management at INTEC. SBW is high in transuranics (TRU) and is best characterized as mixed transuranic waste.

Steam Reforming: An SBW treatment alternative involving heating SBW with additives and steam to form a solid particulate waste.

Tank solids: Any and all solids contained in the Tank Farm tanks.

Tank solids, settled: Heavier tank solids that lay at the bottom of the tanks.

Tank solids, entrained: Tank solids, both suspended and settled, that are sucked up by the steam jets and transported with the liquid SBW to further treatment.

Feed Composition for the Sodium-Bearing Waste Treatment Process

1. INTRODUCTION

Radioactive liquid waste has been generated over the last five decades at the Idaho Nuclear Technology and Engineering Center (INTEC), formerly called the Idaho Chemical Processing Plant, as a result of nuclear fuel reprocessing activities. From December 1963 until June 2000, the Waste Calcining Facility (WCF) and the New Waste Calcining Facility (NWCF) processed the liquid waste into a granular, solid form. As of June 1, 2004, approximately 960,000 gallons of waste remained in Tank Farm tanks at INTEC.[a] Waste in the Tank Farm is referred to as sodium-bearing waste (SBW). Additional liquid waste, called newly generated liquid waste (NGLW), is being generated and will be generated in the future as a result of filter leach operations, equipment and building decontamination activities, Resource Conservation and Recovery Act (RCRA) closure activities, and other operations at INTEC.

Five processes have been developed and evaluated for treating these wastes (Barnes 2004).

- Cesium ion exchange (CsIX) followed by immobilization of the ion exchange effluent
- Calcination using the NWCF with an upgraded off-gas treatment system to comply with Maximum Achievable Control Technology (MACT) standards
- Steam reforming
- Direct evaporation
- Vitrification.

Feasibility studies have been performed on each of these treatment alternatives. To perform conceptual and detailed designs, feed compositions, volumes, and properties are needed. This report presents a compilation of SBW and NGLW feed characterization data.

Based on present Tank Farm management plans, the feed to any SBW/NGLW treatment process is expected to be stored in six tanks. SBW will be stored in three Tank Farm tanks – WM-187, WM-188, and WM-189. These tanks each have a capacity of 300,000 gallons. NGLW will be stored in three 18,400-gal tanks – WM-100, WM-101, and WM-102. Solids contained in heels from other Tank Farm tanks have been flushed to tank WM-187. Thus, Tank WM-187 contains a relatively high proportion (~7 wt %) of solids. Waste in WM-188 and WM-189 have a lower proportion (<1 wt %) of solids.

1.1 Source Characterization Data and Documents

Over the years, numerous compilations of Tank Farm waste compositions have been prepared for different purposes. Documents that contain information relevant to present or future tank compositions are briefly described below.

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[a] This volume excludes about 35,000 gallons of flush water remaining in Tanks WM-181, -182, -183, -184, -185 and -186.

1.1.1 Historical and Present Tank Farm Liquid Composition

Engineering Design File (EDF) 1598 contains a brief review of previous documents containing Tank Farm composition data, a compilation of Tank Farm liquid composition analytical data up through January 2000, estimates of Tank Farm solids volume, and an estimate of NGLW composition.

1. M. D. Staiger, C. B. Millet, R. A. Nickelson, R. A. Wood, A. Chambers, 2001, "Tank Farm Facility, Tank and Waste Data," *Engineering Design File EDF-1598*, February 27, 2001.

EDF-1598 compiles analytical results of samples taken from each of the Tank Farm tanks consistent with the liquid waste present in the tanks as of late 2000. In addition, a waste composition for each tank is presented based on averages of analytical results, for those species for which data are available, and estimates for other chemical and radionuclide species. Estimates were based on calculations by Doug Wenzel using ORIGEN2 assuming concentrations in SBW are proportional to all the fuel processes at INTEC over the life of the plant. The results of these calculations for a theoretical average SBW were used to estimate individual species and tank concentrations by assuming that the ratio of the individual species to ^{137}Cs in the waste is proportional to the ratio of the individual species to ^{137}Cs in the "Average SBW". Wenzel's calculations are documented in the following reports:

2. D. R. Wenzel, 1997, "Evaluation of Radionuclide Inventory for Sodium-Bearing Waste," *Engineering Design File EDF-FDO-006/CPP-97080*, November 26, 1997.
3. D. R. Wenzel, 1999, "Calculation of July 1999 Radionuclide Inventory for Sodium-Bearing Waste," *INEEL Interoffice Correspondence*, Wen-20-99, May 18, 1999.
4. D. R. Wenzel, 2000, "Calculation of July 1999 Inventories for INTEC Wastes," *INEEL Interoffice Memorandum*, Wen-27-99, originally issued November 7, 1999 and reissued with corrections August 2000.
5. D. R. Wenzel, 2002, "Relative Inventories of Reactor-Produced Species in INTEC Waste Types," *Engineering Design File EDF-CRPD-001*, November 4, 2002.

Clark Millet maintains a spreadsheet known as the "Tank Farm Composition Database" that includes sample analyses data as well as summary concentrations for each Tank Farm tank. The tables contained in EDF-1598 (Staiger 2001) of both analyses data and summary averages and estimates reflect the Tank Farm Composition Database spreadsheet that was current at the time EDF-1598 was being prepared. A later documentation of summary tank compositions is given in:

6. C. B. Millet, 2003, "Composition of Tank Farm Waste as of October 2002," *INEEL Interoffice Memorandum* Mil-07-02, December 12, 2002 (reissued with one correction September 24, 2003).

Updates to the Tank Farm Composition Database continued after publication of EDF-1598 as described in:

7. D. R. Tyson, 2002, "Validation of the Radionuclide Mass Balance Used in the INTEC SBW WIR Determination Report," *Engineering Design File EDF-1920*, Revision 4, August 29, 2002.
8. M. C. Swenson, 2003, "Validation of the Radionuclide Inventory and Mass Balance Used in the INTEC SBW and Tank Farm Residuals WIR Determination Reports," *Engineering Design File EDF-1920 INEEL/EXT-2001-534*, Revision 5, October 24, 2003.

For the Tank Farm, EDF-1920 reports only radionuclide inventories, and although updated as of late 2003, reports the waste radionuclide inventories as of July 1, 1999.

In early FY 2003 the Tank Farm Composition Database was again updated to:

- Incorporate analysis data from samples taken from Tank WM-180 in 2000
- Incorporate analysis data from samples taken from Tank WM-189 in 2002
- Update the waste volumes and radionuclide decay basis from July 1, 1999 to January 1, 2003
- Adjust the waste compositions in WM-182 and WM-183 due to water flushes of these tanks
- Adjust the WM-185 waste composition due to additions of water and waste from WM-183 transferred in 2000 and 2001
- Adjust the waste composition of WM-187 due to additions of waste to the tank in 2002
- Incorporate additional updates by Doug Wenzel of ORIGEN2 calculations of SBW radionuclide inventories.

The Tank Farm Composition Database serves as the common source and control point for all estimates of present Tank Farm liquid waste composition. The composition will be updated again when all the waste is contained in the three Tanks WM-187, -188, and -189 and the other tanks have been rinsed.

Jerry Christian evaluated data from samples taken in 2000 of Tank WM-180 waste and recommended a surrogate composition for waste from this tank. A comparison of the Tank WM-180 liquid composition based on 2000 sample analyses with analyses of samples taken in 1993 is given in Table 34 (see Section 3.3). Christian's report also contains compositional data for the solids in WM-180, both analytical data and results of thermodynamic modeling, and a recommended composition for simulating WM-180 waste.

9. J. D. Christian, 2001, *Composition and Simulation of Tank WM-180 Sodium-Bearing Waste at the Idaho Nuclear Technology and Engineering Center*, INEEL/EXT-2001-00600, May 2001.

The SBW in Tank WM-180 will be concentrated by evaporation in late 2004, and the concentrate sent to Tank WM-187. The analysis reported by Christian was used to simulate the evaporation of this waste and calculate the expected future composition of Tank WM-187. The simulation was performed using Aspen Plus, with ASPEN property models tuned to data from historical evaporation of INTEC wastes.

10. J. A. Nenni, 2004, "ETS Process Parameter and Outlet Stream Predictions for WM-180 Feed," *INEEL Interoffice Memeorandum to J. P. Law,* JAN-04-04, February 16, 2004.

Tom Batcheller and Dean Taylor evaluated liquid and solids analytical data from FY 2002 WM-189 samples and present their results in the document below. In addition to a recommended composition for Tank WM-189 waste, Batcheller and Taylor present uncertainties associated with each component concentration. No additional waste has been or will be added to Tank WM-189; hence the composition for this tank at the time of treatment will be the same as the analyses reported by Batcheller and Taylor.

11. T. A. Batcheller, D. D. Taylor, 2003, *Characterization of Tank WM-189 Sodium-Bearing Waste at the Idaho Nuclear Technology and Engineering Center*, INEEL/EXT-02-01171 Rev. 1, July 2003.

Samples from Tank WM-188 were taken in late November 2002 and analyzed in 2003. The reference below contains the results of the analyses for both liquids and solids from the tank. In contrast to the procedure used for Tank WM-189 solids, the solids from WM-188 were washed with water prior to analysis. Tank WM-188 was approximately 75% full when sampled, and additional waste has been and will continue to be added to WM-188 through FY 2005

12. V. J. Johnson, R. L. Demmer, T. A. Batcheller, 2003a, Characterization of Tank WM-188 Sodium-Bearing Waste at the Idaho Nuclear Technology and Engineering Center, INEEL/EXT-03-00478, June 2003.

1.1.2 Tank Solids Compositions

Samples of undissolved solids have been taken from Tank Farm tanks on eleven occasions. Christian (2001), Batcheller (2003) and Johnson (2003a) report analyses of solids from Tanks WM-180, WM-189 and WM-188 respectively. Waste from each of these tanks was transferred by steam jet to a tank in the NWCF blend and hold cell, where it was sampled. Solids contained in the samples were thus solids entrained with the liquid waste during jet transfer.

Samples of the heel in Tanks WM-182, WM-183, and WM-188 were taken directly using the Light Duty Utility Arm (LDUA) sample end effector. Results of the analyses of these samples are contained in the following reports:

13. M. Patterson, 1999, *Light Duty Utility Arm Deployment in Tank WM-188*, INEEL/EXT-99-01302, December 1999.
14. *Idaho Hazardous Waste Management Act/Resource Conservation and Recovery Act Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-182 and WM-183*, DOE/IC-10802, (2001) Appendix B, “Data Summary for Tanks WM-182 and WM-183,” DOE/ID-10802, November 2001.
15. A. Poloski, 2000a, “Solids Characterization,” *Engineering Design File EDF-TST-001*, September 20, 2000.

The above two references contain chemical and physical property data for solids that were present in the heels of Tanks WM-182 and WM-183 when sampled in 2000. Solids from these two tanks have since been flushed to Tank WM-187.

Revision 4 of EDF-1920 (Tyson 2002) includes a summary of the inventory of radionuclides in each tank, and makes a significant correction to the ^{137}Cs concentration of WM-182 solids reported by Poloski. The radionuclide inventories shown by Tyson for tanks other than WM-182, WM-183, and WM-188 are estimates.

Johnson and Demmer report the results of analyses of a sample taken from Tank WM-181 in 2003. Solids in WM-181 were flushed to Tank WM-187 in mid-2004.

16. V. J. Johnson, R. L. Demmer, 2003b, *Characterization of Tank WM-181 Sodium-Bearing Waste Solids at the Idaho Nuclear Technology and Engineering Center*, INEEL/EXT-03-00979, September 2003.

Mike Swenson compiled some older analyses of tank solids, includes a description of sources of solids that went into the Tank Farm tanks and also includes some data that show how solids composition varies with particle size. While the analyses he reports do not represent solids in any present tank, the data is useful in determining the potential range of solids composition.

17. M. C. Swenson, 1992, "Historical Tank Farm Sample Results," *INEL Correspondence*, MCS-27-92, December 17, 1992.

WM-187 was sampled multiple times in late 2003 and early 2004, and results of the analysis of solids from these samples are reported in Section 3.2 of this report. Characterization of solids from Tank WM-186 was performed in 2003 as part of work to develop a tank solids simulant, and the results reported in Revision 3 of this report (Barnes 2003). A summary composition is retained in this report (see Table 28). Techniques used to characterize the solids included transmission electron microscopy, scanning electron microscopy, x-ray fluorescence, and x-ray diffraction. Some of these analyses were repeated for a sample of Tank WM-187 solids taken in late 2003; some of these results will be contained Wendt, 2004 (see #20 below). Additional results from these analyses will be discussed in a report to be written by Stuart Janikowski and published later this year.

1.1.3 Tank Solids Mass Estimates and Properties

EDF-TST-001 (Poloski 2002a) gives estimates of the volume of "sludge" (the solids/liquid residual in a tank after removing liquid waste) in each tank. Poloski used these estimated tank sludge volumes plus a solids concentration as documented in EDF-15722-040 (see the reference below) to derive estimates of the mass of tank solids present in each tank.

18. A. P. Poloski, 2000b, "INTEC Tank Farm Sludge Density Measurements/Calculations," *Engineering Design File 15722-040*, July 12, 2000.

Poloski's estimates of the mass of tank solids have been used in INTEC Waste Incidental to Reprocessing (WIR Determination) documents and various SBW treatment mass balances made in previous years. New estimates are proposed in Section 3.1 of this report for use in Conceptual Designs for SBW treatment alternatives.

Poloski (2002b) also documents the volume fraction of solids in WM-183 sludge and the solids particle density from measurements of the mass and volume of the sludge sample, the weight fraction of water in the sludge, and the density of water. EDF-TST-001 (Poloski 2002a) includes particle size distribution data for solids from Tanks WM-182 and WM-183 and settling rate data for solids from Tank WM-182. Christian (2001) includes particle size distribution data for Tank WM-180 solids. Batcheller (2003) presents particle size distribution data for solids from WM-189 as well as other solids and sludge properties. A summary of solids property data including that for the most recent sample from Tank WM-187 is presented in Section 3.5 of this report. Additional solids property data has been obtained in conjunction with the development of simulants for SBW solids. The initial stimulant development work was performed at the Savannah River Technical Center and is reported by John Harbor:

19. J. R. Harbour, R. F. Schumacher, A. Choi, A. K. Hansen, 2002, *Development of an Initial Simulant for the Idaho Tank Farm Solids*, WSRC-TR-2002-00436, November 11, 2002.

Continued characterization of physical properties of tank sludges for the purpose of stimulant development has been performed and reported by Dan Wendt. Wendt includes data for sludge density, viscosity, and settling rates for different sludge solids concentrations as well as actual waste.

20. D. Wendt, 2004, *INTEC SBW Solid Sludge Surrogate Recipe and Validation*, ICP/EXT-04-00415 Rev. 0, June 2004.

1.1.4 NGLW Stream Volumes and Compositions

Joe Nenni compiled compositional data for NGLW streams based on analysis of samples taken from FY-1999 through FY-2002. He includes compositional data for cations, anions, pH or acidity, undissolved solids (UDS), total inorganic carbon (TIC), total organic carbon (TOC), semi volatile organic compounds, and volatile organic compounds. No radionuclide compositional data are included.

21. J. A. Nenni, 2002, "Balance-of-Plant Sample Data Compilation," *Engineering Design File,* EDF-2506, September 2002.

Julia Tripp compiled NGLW compositional data from sample analysis prior to FY-1999. Compositions are provided by NGLW stream and include, when available, radionuclide activities.

22. J. L. Tripp, 1998, *Supporting Information for the INEEL Liquid Waste Management Plan*, Appendix B, INEEL/EXT-98-00730, July 1998.

The latest projections of the volumes of wastes that will be generated by various operations at INTEC are given in the following document:

23. R. Demmer, 2002, *INTEC Waste Minimization Plan*, PLN-225, October 15, 2002.

Demmer also includes a comparison of projections with actual generation rates for NGLW streams in each of the years 1998-2001. Following the guidelines of PLN-225, volumes of waste projected to be generated from 2004-2012 are summarized in Tables 11 and 12 of Section 2.4 of this report.

1.1.5 Present and Future Liquid Volumes

Present Tank Farm tank volumes are based on tank level measurements. A web-based monthly update of tank volumes is available at http://icpweb.inel.gov/intec/tank-farm-data/. An Excel spreadsheet model (see Palmer 2000) is used to project future tank volumes. This model includes volumes of NGLW generated each year, volumes of NGLW after concentration by evaporation, and volumes of Tank Farm tanks by month. As Tank Farm management plans and assumptions change, the model is updated. The most recent update was made by Clark Millet in early March 2004 to incorporate the consolidation of SBW into the three tanks, WM-187, WM-188, and WM-189. Portions of the data in this unpublished spreadsheet ("2012 Model – Barnes7," March 8, 2004) are contained in this report.

1.1.6 Tank Farm Background Information

Brent Palmer has documented the history and discussed operation of the INTEC Tank Farm, INTEC waste management equipment, and SBW and NGLW management plans. While the plans and waste compositions in the report below are no longer current, the history and discussion of equipment and INTEC operations is useful.

24. W. B. Palmer, C. B. Millet, M. D. Staiger, M. C. Swenson, W. B. McNaught, F. S. Ward, 2000, *INTEC Waste Management Through 2070,* INEEL/EXT-2000-01005, December 2000.

1.2 Feeds to the Alternative Treatment Processes

Waste to be treated by the SBW Treatment Facility includes:

1. SBW stored in Tank WM-187, including solids and liquid. Heel solids from Tanks WM-181, WM-182, WM-183, WM-184, WM-185, and WM-186 have been collected in Tank WM-187. Following collection of these heels, much of the liquid content of the tank will be removed. Concentrate from evaporation of Tank WM-180 SBW will then be added to the tank. Small additions of other wastes generated in 2004 and 2005 are expected to fill this tank.
2. SBW stored in Tank WM-188, including liquid and a relatively small amount of undissolved solids. Tank WM-188 is presently about 90% full; waste will continue to be added through FY 2005.
3. SBW stored in Tank WM-189, including liquid and a relatively small amount of undissolved solids. Tank WM-189 is presently full (near its administrative limit) and no changes in waste composition are expected for this tank.
4. NGLW that will be collected in Tanks WM-100, WM-101, and WM-102 from FY 2006 through the end of SBW treatment. Transfers into and out of these tanks will be made until (and possibly during) the period of SBW treatment. Should NGLW generation prior to the start-up of the SBW treatment facility exceed the capacity of these tanks, other INTEC tanks would also be used to store NGLW.

The following sections discuss differences in the feeds to each of the treatment processes. Additional discussion of possible tank mixing scenarios is given in Section 3.4.

1.2.1 CsIX/TRU Grout

Several strategies for processing the waste in the CsIX/ treatment alternative are possible. One strategy would be to sequentially process the waste by tank. For example, waste from Tank WM-187 could be processed first, then waste from WM-188, followed by waste from WM-189, and finally NGLW. Other strategies would involve changing the order of tanks processed or blending wastes from different SBW and/or NGLW tanks in the treatment facility receiving tank prior to feeding to treatment operations. If processed tank by tank, the feed to the treatment process would vary from the relatively high solid waste of WM-187 to the low solids waste of the other tanks. In addition to processing the bulk volume of waste from each tank, the heel will also need to be processed. The heels would be flushed to the treatment facility using water.

The CsIX/TRU Grout process will generate small amounts of dilute aqueous wastes that can be processed in existing INTEC evaporators and the concentrate returned to the treatment process. These wastes include water from rinsing tank solids and/or spent ion exchange media, condensate from drying tank solids and spent ion exchange media, and vent gas condensate.

1.2.2 Calcination/MACT

If calcination is selected for SBW treatment, decontamination of NWCF cells could begin as early as 2005 or 2006, resulting in waste not generated for the other options. This NWCF cell decontamination waste would be concentrated and added to WM-188 through FY 2005 or WM-100, WM-101, and WM-102 after 2005. Unlike the CsIX process, no dilute liquid wastes are expected to be generated continually during operation, but wastes would be generated intermittently during scheduled and unscheduled shutdowns, and also from decontamination activities after SBW processing is complete.

A separate study (Wood 2002) has recommended that solids be mixed with liquid tank waste in TFF tanks and processed together (co-processed) in the calciner. The present plan for Tank Farm management includes the addition of concentrated SBW, primarily from Tank WM-180, to Tank WM-187. Mixing pumps would need to be installed in WM-187 to maintain a homogeneous blend of solids and liquid to be fed to treatment. Mixing pumps could be installed WM-188 and/or WM-189 as well, and waste transfers made between the four tanks WM-187, WM-188, WM-189, and WM-190 to produce a feed with a more consistent solids content than if all the solids remain in WM-187. A discussion of possible tank mixing scenarios is given is Section 3.4.

1.2.3 Steam Reforming

The waste feed to the Steam Reforming process would be nearly identical to the feed for the Calcination/MACT alternative. Minor differences in NGLW composition between these two alternatives, because of differences in NGLW streams, would cause very minor differences in feed composition. Like calcination, solids would be co-processed.

1.2.4 Direct Evaporation

Co-processing of solids has also been recommended and demonstrated for the Direct Evaporation process (Packer 2003; Griffith 2003). Feeds to the process would essentially be the same as the feeds for the calcination and steam reforming alternatives, with only small differences due to differences in NGLW composition and volume between what would be generated for the direct evaporation alternative and the calcination or steam reforming alternative. No NGLW is expected to be generated by the Direct Evaporation process.

1.2.5 Vitrification

A mass balance was prepared in 2001 assuming separate vitrification of SBW liquids and solids (Quigley 2001). No glass formulation tests have been performed with simulants for tank solids either alone or with SBW liquid. The high phosphate content of SBW solids will severely limit its waste loading in a borosilicate glass. Further evaluations would be needed to determine whether to coprocess tank solids with SBW liquid or process the two wastes separately.

1.3 Tank Farm Management

Figure 1 illustrates management of INTEC wastes from February 2004 through June 2004. During this time, Tank WM-187 received dilute wastes. Figure 2 illustrates management of INTEC wastes from July 2004 through September 2005. During this period, waste will be received into Tanks WM-187 and WM-188, but Tank WM-187 will contain concentrated waste. After September 2005, no changes will be made to the waste in Tanks WM-187, WM-188, and WM-189, and all waste generated will be stored in Tanks WM-100, WM-101, and WM-102, as illustrated in Figure 3.

As of January 31, 2004, Tank WM-187 contained 150,900 gallons of SBW solids plus dilute aqueous waste. In early-2004, Tanks WM-103, WM-104, WM-105, WM-106, and WM-181 were washed, with the wash water added to Tank WM-187. Flushes from WM-103, WM-104, WM-105 and WM-106 were very dilute, but the flush from WM-181 contained approximately 15,000 gallons of heel, both solids and concentrated liquid. In mid-2004, most of the liquid waste in WM-187 will then be sent to the Evaporator Tank System (ETS), reducing the volume of waste in WM-187 to an estimated 45,000 gallons.[b] Then concentrate from evaporation of Tank WM-180 waste will be added to Tank WM-187. The total waste from WM-180 is expected to amount to about 230,000 gallons, including both the evaporator concentrate and heel flush. An additional 10,000 gallons of NGLW generated in 2004 and 2005 is expected to be added to WM-187, filling the remaining tank capacity.

The volume of waste in Tank WM-188 as of January 31, 2004 was 241,000 gallons. Evaporator concentrates have been and will be added in 2004 and 2005 to fill this tank. Tank WM-189 presently contains 279,700 gallons of waste. No changes are anticipated in the waste contained in Tank WM-189.

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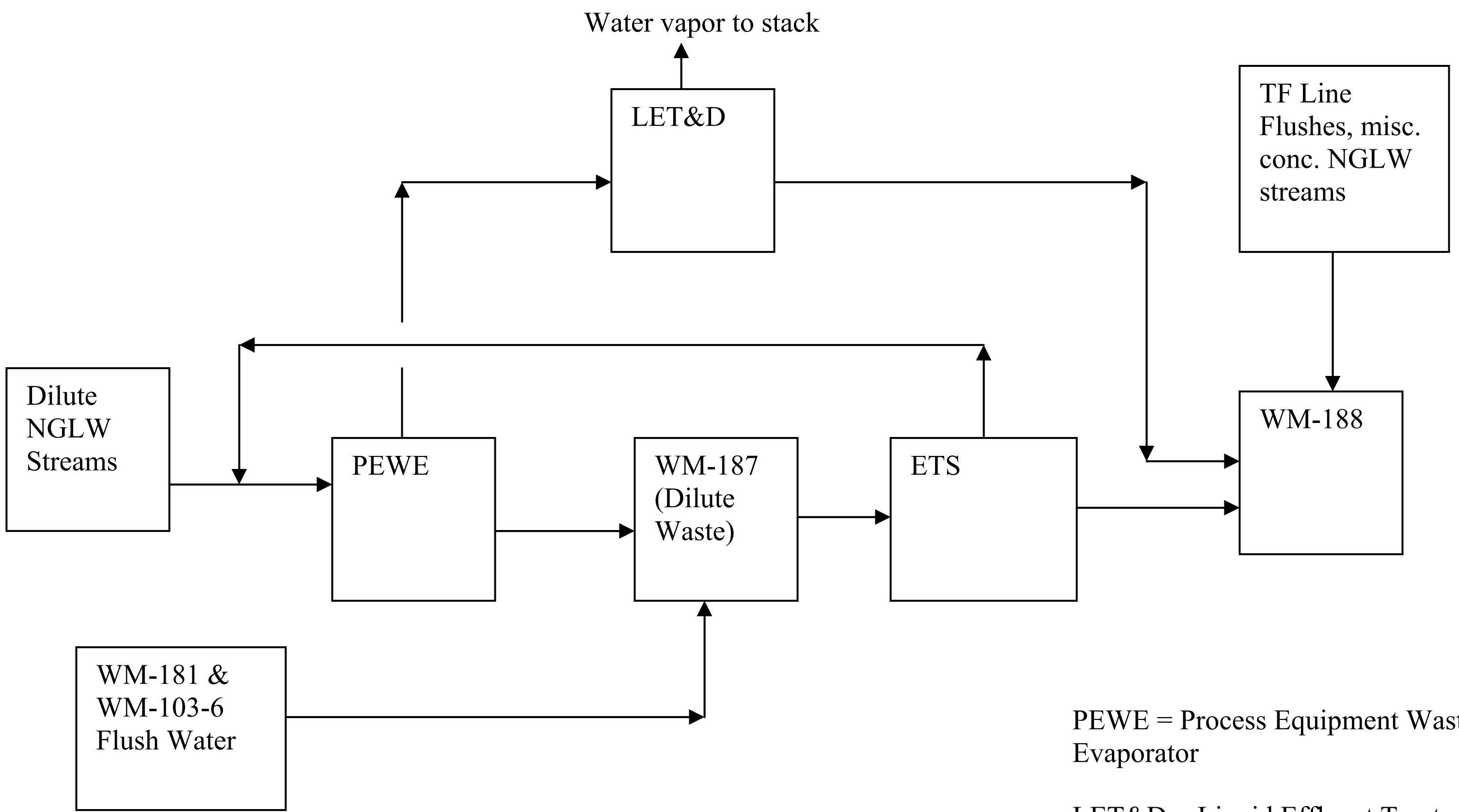
[b] The estimate of 45,000 gallons was made in March 2004 and is shown in the Tank Farm management scenario spreadsheet. However, evaporation of Tank WM-187 was stopped in April when the level was at 58,000 gallons. Hence it is likely the minimum volume of the tank after the next evaporation will be around 60,000 gallons.



PEWE = Process Equipment Waste Evaporator

LET&D = Liquid Effluent Treatment and Disposal Facility (includes a waste fractionator)

ETS = Evaporator Tank System (formerly called the High Level Liquid Waste Evaporator)

NGLW = Newly Generated Liquid Waste

TF = INTEC Tank Farm

Figure 1. Tank Farm Management February 2004 – June 2004.

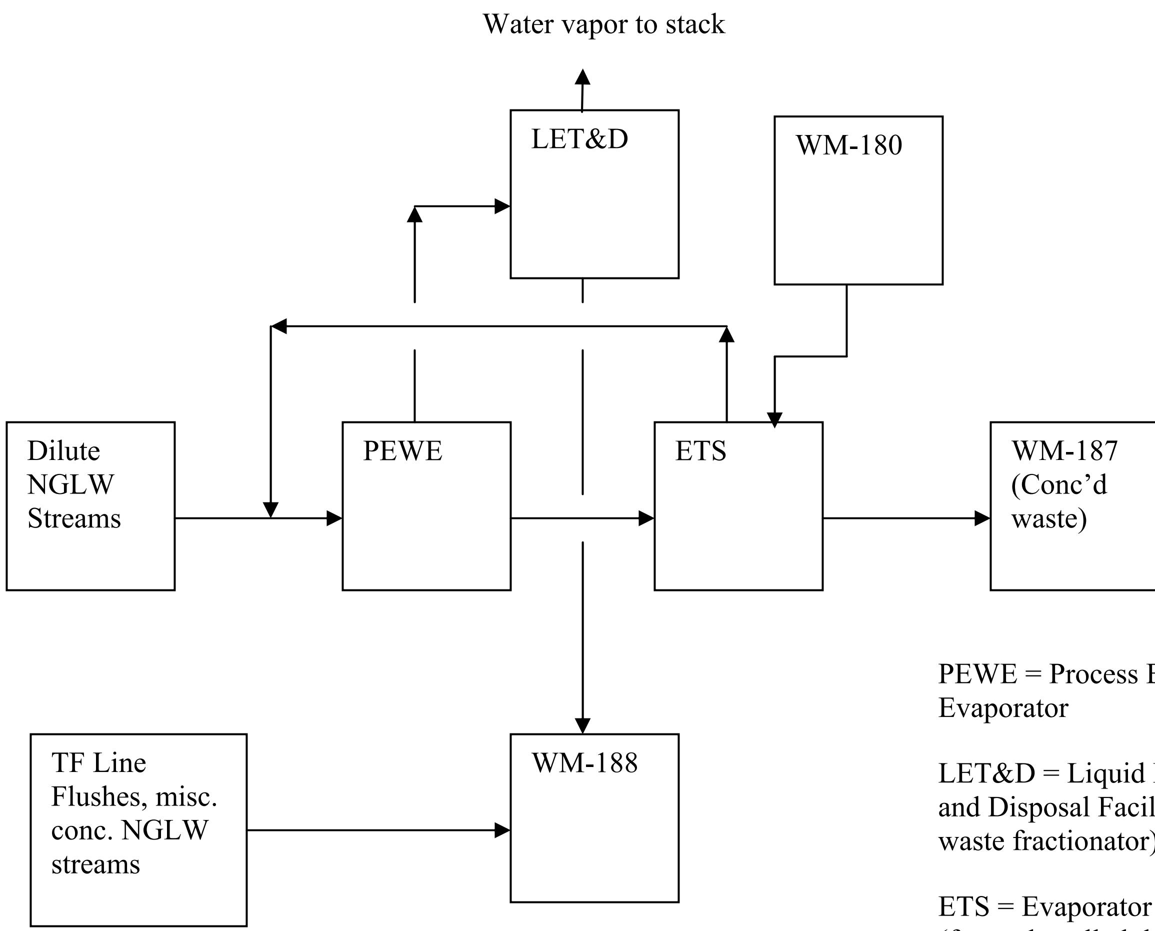


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Figure 2. Tank Farm Management, July 2004 – September 2005.

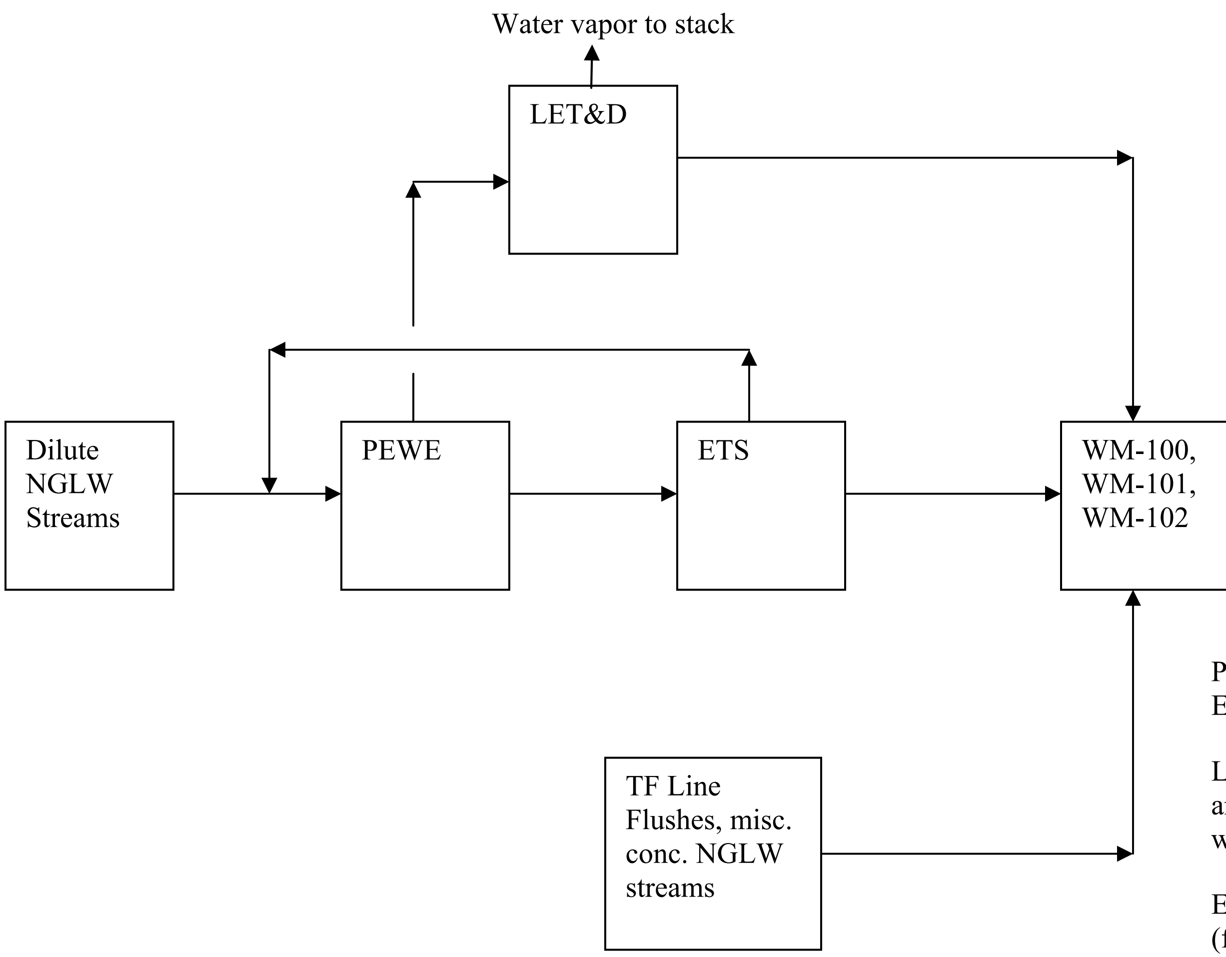

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Figure 3. INTEC Waste Management after September 2005.

2. PROJECTED WASTE COMPOSITIONS

This section identifies the sources and amounts of wastes that will be in tanks fed to the treatment process. It also projects compositions of the liquids, solids, and combined liquids and solids in these tanks and discusses the basis for calculating these compositions.

2.1 WM-187 Composition

The starting point for calculation of the future composition of WM-187 waste is the composition as of September 2002 as documented by Clark Millet (Millet 2003). Table 1 summarizes the path from the September 2002 composition to the future composition in September 2005. No changes in the tank waste are anticipated after September 2005.

Table 1. Basis for Tank WM-187 waste composition.

	Gallons	**Composition ID**
Volume Sept 30, 2002	137,300	WM-187-0
Transfer of WM-183 waste	15,400	WM-183-0
Water with WM-183 flush	77,100	Water
Subtotal	229,800	WM-187-1
Sent to Evaporator	212,300	WM-187-1
Remaining in WM-187	17,500	WM-187-1
Waste from WM-184	5,100	WM-184-0
Waste from WM-185	12,900	WM-185-0
Waste from WM-186	19,700	WM-186-0
Waste from WM-181	23,000	WM-181-0
Water with WM-181/4/5/6 flushes	152,700	Water
NGLW added through June 2004	3,606	NGLW-1
Subtotal	234,506	WM-187-2
Sent to Evaporator	189,546	WM-187-2
Remaining in WM-187	44,960	WM-187-2

	Liquid (Gallons)	Composition ID	**Solids** (Gallons)	Composition ID	**Total** (Gallons)	Composition ID
Initial WM-187 waste	31,750	WM-187-2	13,210	WM-187-S1	44,960	
Added from WM-180 evaporation	203,913	WM-180-C	87	WM-180-S	204,000	
WM-180 heel	5,625	WM-180-0	661	WM-180-S	6,286	
Water from WM-180 heel flush	20,000	Water			20,000	
WM-190	500	WM-190-0			500	
Water from WM-190 transfer	300	Water			300	
NGLW, July 2005 - March 2005	8,874	NGLW-2			8,874	
Final WM-187 Volume	**270,963**	**WM-187-L**	**13,958**	**WM-187-S**	**284,920**	**WM-187**

The composition of the waste in Tank WM-187 after Tank WM-183 flushes were added was calculated by adding the initial tank contents (WM-187-0, as reported by Millet 2003), the waste heel from WM-183 (WM-183-0, also as reported by Millet 2003), and the amount of water used to flush WM-183. The resulting composition was named “WM-187-1.” Seven wastes were then added together to calculate the composition of the Tank WM-187 waste after flushing Tanks WM-184, WM-185, WM-186, and WM-181. These seven streams included 17,500 gallons of waste initially in the tank (composition "WM-187-1"), heels from the four tanks flushed (compositions as reported by Millet, 2003), 152,700 gallons of water used in flushing, and 3,606 gallons of NGLW. The calculation of the NGLW composition is described in Section 2.4. The resulting composition was called "WM-187-2". Of the 234,506 gallons of WM-187-2 waste, 189,546 gallons of the liquid is expected to be drawn off to the evaporator, leaving 44,960 gallons in the tank. It was assumed that the waste remaining in the tank contained all the solids present in the full volume.

Based on an estimate of 100,000 kg of solids in WM-187 (see Section 3.1), and a solids particle density of 2 kg/liter (Poloski 2000b), the volume of solids in the tank equates to 13,210 gallons, and implies that the tank sludge contains 31,730 gallons of interstitial liquid. This volume of liquid, of composition "WM-187-2," was combined with the volumes of six other wastes as shown in Table 1 to obtain the final composition of Tank WM-187 liquid waste. The sources for the compositions of the other wastes include Nenni (2004) for concentrated waste from WM-180; Millet (2003) for the WM-180 heel liquid and WM-190 heel liquid; and calculation of the NGLW-2 composition as described in Section 2.4.

The composition of the final solids in Tank WM-187 was calculated based on an initial Tank WM-187 solids composition, prior to the addition of WM-180 waste, and adding to these the solids from WM-180. The composition of the WM-180 heel solids was assumed to be the same as the entrained WM-180 solids, which were analyzed in 2000 (Christian 2000).

Because of the uncertainty in the amount of solids in Tank WM-187, compositions were calculated based on the expected amount of solids, 70% of the expected amount, and 130% of the expected amount. Table 2 shows the composition of Tank WM-187 liquid only and liquid plus the expected solids. Table 3 shows the composition of waste in Tank WM-187 waste at the low and high ends of the estimated solids quantity.

The concentrations of nitrates shown in Tables 2-3 have been adjusted from measured values to achieve an overall charge balance in the total composition. The specific gravity and concentrations for total organic carbon (TOC) shown in Tables 2 and 3 are estimates. The TOC concentrations are based on TOC analysis of waste samples from Tanks WM-188 and WM-189. The specific gravity is based on a correlation of specific gravity for historic tank samples and total dissolved solids.

The composition of solids only is shown in Table 4. The solids composition is based in part on the analytical results of the most recent sample from Tank WM-187, but where these results significant diverge from previous samples, it is based on solids analyses data averages. Uncertainties in the liquid and solids compositions are discussed in Section 3.3.

Table 2. Tank WM-187 composition.

	Liquid only	With solids		Liquid only	With solids		Liquid only	With solids		Liquid only	With solids
Gal	270,963	284,920		mol/liter	mol/liter		Ci/liter	Ci/liter		Ci/liter	Ci/liter
SG	1.30	1.32	PO_4^{-3}	1.38E-02	3.22E-01	Th-232	4.26E-16	4.26E-16	Tc-98	1.55E-12	1.55E-12
			Pu^{+4}	6.32E-06	2.30E-05	Th-234	1.25E-08	1.25E-08	Tc-99	1.06E-05	6.43E-05
	mol/liter	mol/liter	K^{+}	2.23E-01	2.24E-01	Pa-231	5.38E-11	5.38E-11	Ru-106	5.60E-07	1.72E-06
H+	1.09E+00	1.04E+00	Pr^{+4}	5.21E-06	4.96E-06	Pa-233	1.76E-06	1.76E-06	Rh-102	5.19E-10	5.19E-10
Al^{+3}	6.73E-01	7.08E-01	Pm^{+3}	7.63E-10	2.21E-07	Pa-234m	1.25E-08	1.25E-08	Rh-106	5.60E-07	1.72E-06
Am^{+}	9.41E-08	1.30E-07	Rh^{+4}	2.25E-06	2.14E-06	U-232	1.20E-09	4.03E-09	Pd-107	9.95E-09	9.95E-09
Sb^{+5}	5.36E-07	3.24E-05	Rb^{+}	3.46E-06	3.29E-06	U-233	4.81E-11	9.70E-11	Cd-113m	2.00E-06	2.00E-06
As^{+5}	4.92E-04	5.53E-04	Ru^{+3}	1.28E-04	1.10E-03	U-234	1.18E-06	1.51E-06	In-115	6.06E-17	6.06E-17
Ba^{+2}	5.54E-05	1.20E-04	Sm^{+3}	3.43E-06	3.36E-06	U-235	4.38E-08	7.49E-08	Sn-121m	4.03E-08	4.03E-08
Be^{+2}	7.81E-06	1.79E-05	Se^{+4}	1.11E-05	1.24E-04	U-236	6.38E-08	1.17E-07	Sn-126	2.47E-07	7.54E-07
B^{+3}	1.26E-02	1.35E-02	Si^{+4}	5.37E-05	5.93E-01	U-237	3.87E-09	3.87E-09	Sb-125	8.03E-06	8.18E-04
Br^{-}	1.90E-07	1.81E-07	Ag^{+}	5.43E-06	9.11E-04	U-238	2.76E-08	3.36E-08	Sb-126m	2.47E-07	2.47E-07
Cd^{+2}	8.03E-04	8.62E-04	Na^{+}	2.20E+00	2.13E+00	Np-237	1.76E-06	4.07E-16	Sb-126	3.46E-08	3.46E-08
Ca^{+2}	4.98E-02	4.95E-02	Sr^{+2}	1.22E-04	1.22E-04	Np-238	5.91E-11	1.54E-06	Te-123	2.31E-19	2.31E-19
Ce^{+4}	4.83E-05	9.53E-05	SO_4^{-2}	7.04E-02	7.32E-02	Np-239	1.67E-08	4.58E-11	Te-125m	1.90E-06	1.90E-06
Cs^{+}	1.17E-05	8.31E-05	Tc^{+7}	6.30E-06	3.83E-05	Pu-236	1.65E-09	5.89E-09	I-129	2.83E-08	9.39E-08
Cl^{-}	3.34E-02	3.99E-02	Te^{+4}	1.85E-06	1.76E-06	Pu-238	6.28E-04	2.15E-03	Cs-134	8.52E-06	7.41E-05
Cr^{+3}	3.67E-03	4.34E-03	Tb^{+4}	1.32E-09	1.25E-09	Pu-239	8.98E-05	3.26E-04	Cs-135	5.18E-07	1.46E-06
Co^{+2}	1.97E-05	3.44E-05	Tl^{+3}	1.00E-07	4.25E-05	Pu-240	6.08E-06	2.24E-05	Cs-137	3.04E-02	8.25E-02
Cu^{+2}	6.93E-04	7.91E-04	Th^{+4}	7.28E-07	6.92E-07	Pu-241	1.66E-04	1.56E-03	Ba-137m	2.87E-02	7.80E-02
Eu^{+3}	3.15E-07	3.02E-07	Sn^{+4}	1.05E-06	3.48E-03	Pu-242	4.84E-09	1.72E-08	La-138	1.15E-16	1.15E-16
F^{-}	5.06E-02	7.40E-02	Ti^{+4}	6.09E-05	1.91E-03	Pu-244	4.08E-16	1.29E-15	Ce-142	1.80E-11	1.80E-11
Gd^{+3}	1.82E-04	1.86E-04	U^{+4}	4.36E-04	5.76E-04	Am-241	7.76E-05	1.07E-04	Ce-144	3.77E-07	1.16E-06
Ge^{+4}	5.48E-09	5.22E-09	V^{+5}	9.69E-04	9.48E-04	Am-242m	9.16E-09	9.16E-09	Pr-144	3.77E-07	3.92E-07
In^{+3}	8.63E-07	8.63E-07	Y^{+3}	4.27E-06	4.06E-06	Am-242	9.11E-09	9.11E-09	Nd-144	9.68E-16	9.68E-16
I^{-}	1.58E-06	4.38E-06	Zn^{+2}	1.05E-03	1.22E-03	Am-243	1.29E-08	2.37E-08	Pm-146	3.06E-08	3.06E-08
Fe^{+3}	2.17E-02	3.57E-02	Zr^{+4}	1.70E-04	5.41E-02	Cm-242	8.04E-09	1.34E-08	Pm-147	1.03E-04	3.11E-04
La^{+3}	5.73E-06	5.45E-06	O-2		9.29E-01	Cm-243	1.71E-08	6.24E-08	Sm-146	1.66E-13	1.66E-13
Pb^{+2}	1.34E-03	1.35E-03	H2O	4.74E+01	4.53E+01	Cm-244	1.04E-06	5.06E-06	Sm-147	4.43E-12	4.43E-12
Li^{+}	3.96E-04	6.43E-04				Cm-245	1.80E-10	8.60E-10	Sm-148	2.28E-17	2.28E-17
Mg^{+2}	1.30E-02	1.41E-02		g/liter	g/liter	Cm-246	1.18E-11	5.60E-11	Sm-149	2.02E-18	2.02E-18
Mn^{+4}	1.52E-02	1.59E-02	TOC	0.53	0.50				Sm-151	2.02E-04	6.18E-04
Hg^{+2}	2.07E-03	2.23E-03	UDS	0	93	H-3	1.99E-05	1.99E-05	Eu-150	8.66E-12	8.66E-12
Mo^{+6}	2.00E-04	5.05E-04				Be-10	1.81E-12	1.81E-12	Eu-152	1.52E-06	2.52E-06
Nd^{+3}	1.85E-05	1.76E-05		Ci/liter	Ci/liter	C-14	7.23E-11	2.21E-10	Eu-154	5.92E-05	9.24E-05
Np^{+4}	1.06E-05	1.10E-05		(Jan, 2003)	(Jan, 2003)	Se-79	2.63E-07	8.77E-07	Eu-155	9.56E-05	1.61E-04
Ni^{+2}	1.48E-03	1.80E-03	Ra-226	4.93E-12	4.93E-12	Rb-87	1.76E-11	1.76E-11	Gd-152	8.56E-19	8.56E-19
Nb^{+5}	3.39E-06	1.66E-03	Ac-227	2.32E-11	2.32E-11	Sr-90	2.38E-02	2.53E-02	Ho-166m	2.77E-11	2.77E-11
NO_3^{-}	5.60E+00	5.44E+00	Th-230	4.95E-10	1.88E-09	Y-90	2.38E-02	2.53E-02	Co-60	6.57E-06	1.18E-05
Pd^{+4}	5.86E-06	2.19E-03	Th-231	1.26E-08	1.26E-08	Zr-93	1.33E-06	1.33E-06	Ni-63	2.80E-05	6.61E-05

Table 3. Tank WM-187 composition with minimum and maximum solids.

	Min Solids	Max solids		Min Solids	Max solids		Min Solids	Max solids		Min Solids	Max solids
Gallon	284,920	284,920		mol/liter	mol/liter		Ci/liter	Ci/liter		Ci/liter	Ci/liter
SG	1.31	1.32	PO_4^{-3}	2.31E-01	4.13E-01	Th-232	4.23E-16	4.30E-16	Tc-98	1.54E-12	1.57E-12
			Pu^{+4}	1.92E-05	2.68E-05	Th-234	1.24E-08	1.26E-08	Tc-99	4.81E-05	8.05E-05
	mol/liter	mol/liter	K^{+}	2.21E-01	2.26E-01	Pa-231	5.33E-11	5.43E-11	Ru-106	1.37E-06	2.07E-06
H+	1.05E+00	1.03E+00	Pr^{+4}	4.99E-06	4.93E-06	Pa-233	1.75E-06	1.78E-06	Rh-102	5.15E-10	5.23E-10
Al^{+3}	6.91E-01	7.24E-01	Pm^{+3}	1.55E-07	2.88E-07	Pa-234m	1.24E-08	1.26E-08	Rh-106	1.37E-06	2.07E-06
Am^{+4}	1.19E-07	1.42E-07	Rh^{+4}	2.15E-06	2.12E-06	U-232	3.19E-09	4.87E-09	Pd-107	9.86E-09	1.00E-08
Sb^{+5}	2.32E-05	4.16E-05	Rb^{+}	3.31E-06	3.27E-06	U-233	8.22E-11	1.12E-10	Cd-113m	1.98E-06	2.02E-06
As^{+5}	5.27E-04	5.78E-04	Ru^{+3}	8.11E-04	1.39E-03	U-234	1.41E-06	1.62E-06	In-115	6.01E-17	6.11E-17
Ba^{+2}	1.00E-04	1.40E-04	Sm^{+3}	3.35E-06	3.37E-06	U-235	6.51E-08	8.47E-08	Sn-121m	3.99E-08	4.06E-08
Be^{+2}	1.50E-05	2.08E-05	Se^{+4}	1.09E-04	1.39E-04	U-236	1.01E-07	1.34E-07	Sn-126	6.03E-07	9.06E-07
B^{+3}	1.32E-02	1.39E-02	Si^{+4}	4.16E-01	7.70E-01	U-237	3.84E-09	3.91E-09	Sb-125	5.75E-04	1.06E-03
Br^{-}	1.82E-07	1.80E-07	Ag^{+}	6.40E-04	1.18E-03	U-238	3.17E-08	3.55E-08	Sb-126m	2.45E-07	2.49E-07
Cd^{+2}	8.42E-04	8.82E-04	Na^{+}	2.12E+00	2.13E+00	Np-237	4.04E-16	1.88E-06	Sb-126	3.43E-08	3.49E-08
Ca^{+2}	4.92E-02	4.98E-02	Sr^{+2}	1.20E-04	1.23E-04	Np-238	1.48E-06	5.40E-11	Te-123	2.29E-19	2.33E-19
Ce^{+4}	8.09E-05	1.10E-04	SO_4^{-2}	7.17E-02	7.48E-02	Np-239	4.54E-11	1.52E-08	Te-125m	1.88E-06	1.91E-06
Cs^{+}	6.63E-05	9.99E-05	Tc^{+7}	2.87E-05	4.80E-05	Pu-236	4.81E-09	6.96E-09	I-129	7.44E-08	1.13E-07
Cl^{-}	3.75E-02	4.22E-02	Te^{+4}	1.77E-06	1.75E-06	Pu-238	1.80E-03	2.50E-03	Cs-134	5.45E-05	9.37E-05
Cr^{+3}	4.12E-03	4.56E-03	Tb^{+4}	1.26E-09	1.25E-09	Pu-239	2.73E-04	3.80E-04	Cs-135	1.18E-06	1.75E-06
Co^{+2}	3.01E-05	3.88E-05	Tl^{+3}	3.77E-05	4.74E-05	Pu-240	1.83E-05	2.66E-05	Cs-137	6.69E-02	9.80E-02
Cu^{+2}	7.54E-04	8.27E-04	Th^{+4}	6.97E-07	6.87E-07	Pu-241	1.27E-03	1.85E-03	Ba-137m	6.33E-02	9.27E-02
Eu^{+3}	3.03E-07	3.00E-07	Sn^{+4}	2.46E-03	4.50E-03	Pu-242	1.40E-08	2.03E-08	La-138	1.14E-16	1.16E-16
F^{-}	6.65E-02	8.14E-02	Ti^{+4}	1.38E-03	2.44E-03	Pu-244	1.02E-15	1.56E-15	Ce-142	1.78E-11	1.82E-11
Gd^{+3}	1.83E-04	1.89E-04	U^{+4}	5.32E-04	6.20E-04	Am-241	9.80E-05	1.17E-04	Ce-144	9.30E-07	1.40E-06
Ge^{+4}	5.25E-09	5.18E-09	V^{+5}	9.41E-04	9.54E-04	Am-242m	9.08E-09	9.24E-09	Pr-144	3.89E-07	3.95E-07
In^{+3}	8.56E-07	8.71E-07	Y^{+3}	4.09E-06	4.04E-06	Am-242	9.04E-09	9.19E-09	Nd-144	9.60E-16	9.76E-16
I^{-}	3.52E-06	5.23E-06	Zn^{+2}	1.16E-03	1.28E-03	Am-243	2.05E-08	2.70E-08	Pm-146	3.04E-08	3.09E-08
Fe^{+3}	3.16E-02	3.97E-02	Zr^{+4}	3.83E-02	6.99E-02	Cm-242	1.17E-08	1.51E-08	Pm-147	2.49E-04	3.73E-04
La^{+3}	5.48E-06	5.42E-06	O-2	6.53E-01	1.21E+00	Cm-243	4.98E-08	7.51E-08	Sm-146	1.65E-13	1.68E-13
Pb^{+2}	1.33E-03	1.36E-03	H2O	4.61E+01	4.45E+01	Cm-244	3.91E-06	6.21E-06	Sm-147	4.40E-12	4.47E-12
Li^{+}	5.91E-04	6.95E-04				Cm-245	6.66E-10	1.05E-09	Sm-148	2.26E-17	2.30E-17
Mg^{+2}	1.37E-02	1.45E-02		g/liter	g/liter	Cm-246	4.34E-11	6.86E-11	Sm-149	2.01E-18	2.04E-18
Mn^{+4}	1.56E-02	1.63E-02	TOC	0.51	0.50				Sm-151	4.94E-04	7.42E-04
Hg^{+2}	2.21E-03	2.26E-03	UDS	65	121	H-3	1.97E-05	2.02E-05	Eu-150	8.58E-12	8.73E-12
Mo^{+6}	4.15E-04	5.94E-04				Be-10	1.79E-12	1.82E-12	Eu-152	2.21E-06	2.83E-06
Nd^{+3}	1.77E-05	1.75E-05		Ci/liter	Ci/liter	C-14	1.77E-10	2.66E-10	Eu-154	8.25E-05	1.02E-04
Np^{+4}	1.08E-05	1.12E-05		(Jan, 2003)	(Jan, 2003)	Se-79	7.17E-07	1.04E-06	Eu-155	1.41E-04	1.82E-04
Ni^{+2}	1.69E-03	1.91E-03	Ra-226	4.89E-12	4.97E-12	Rb-87	1.75E-11	1.78E-11	Gd-152	8.49E-19	8.63E-19
Nb^{+5}	1.29E-03	2.03E-03	Ac-227	2.30E-11	2.34E-11	Sr-90	2.47E-02	2.59E-02	Ho-166m	2.75E-11	2.80E-11
NO_3^{-}	5.43E+00	5.45E+00	Th-230	1.47E-09	2.29E-09	Y-90	2.47E-02	2.59E-02	Co-60	1.03E-05	1.33E-05
Pd^{+4}	1.54E-03	2.84E-03	Th-231	1.25E-08	1.27E-08	Zr-93	1.32E-06	1.35E-06	Ni-63	2.78E-05	2.83E-05

Table 4. Tank WM-187 composition of solids.

	Weight percent		Weight percent		Ci/kg		Ci/kg
Al^{+3}	1.72E+00	Ni^{+2}	2.36E-02	C-14	1.58E-09	Eu-155	6.96E-04
Sb^{+5}	4.02E-03	Nb^{+5}	1.23E-01	Co-60	5.60E-05	Th-230	1.47E-08
As^{+5}	6.82E-03	NO_3^-	5.65E+00	Ni-59	4.98E-05	U-232	3.00E-08
Ba^{+2}	9.81E-03	Pd^{+4}	2.48E-01	Ni-63	4.11E-04	U-233	5.16E-10
Be^{+2}	9.35E-05	PO_4^{-3}	3.10E+01	Se-79	5.68E-06	U-234	3.35E-06
B^{+3}	1.61E-02	K^+	4.51E-01	Sr-90	1.42E-02	U-235	3.31E-07
Cd^{+2}	1.11E-02	Ru^{+3}	1.05E-01	Y-90	1.42E-02	U-236	5.68E-07
Ca^{+2}	7.20E-02	Se^{+4}	4.21E-03	Tc-99	5.78E-04	U-238	6.32E-08
Ce^{+4}	7.29E-03	Si^{+4}	1.79E+01	Ru-106	1.23E-05	Np-237	1.73E-06
Cs^+	8.08E-03	Ag^+	1.05E-01	Rh-106	1.23E-05	Pu-236	3.82E-08
Cl^-	3.05E-01	Na^+	3.92E-01	Sn-126	5.37E-06	Pu-238	1.23E-02
Cr^{+3}	4.44E-02	Sr^{+2}	4.95E-04	Sb-125	8.72E-03	Pu-239	1.88E-03
Co^{+2}	9.35E-04	SO_4^{-2}	5.89E-01	I-129	6.94E-07	Pu-240	1.47E-04
Cu^{+2}	8.42E-03	Tl^{+3}	3.56E-03	Cs-134	7.07E-04	Pu-241	1.05E-02
F^-	5.29E-01	Sn^{+4}	4.36E-01	Cs-135	1.00E-05	Pu-242	1.11E-07
Gd^{+3}	1.82E-03	Ti^{+4}	9.16E-02	Cs-137	5.51E-01	Pu-244	9.52E-15
Fe^{+3}	8.19E-01	U^{+4}	2.22E-02	Ba-137m	5.21E-01	Am-241	3.05E-04
Pb^{+2}	1.34E-02	V^{+5}	1.40E-03	Ce-144	8.33E-06	Am-243	1.14E-07
Li^+	1.31E-03	Zn^{+2}	1.48E-02	Pr-144	8.33E-06	Cm-242	5.77E-08
Mg^{+2}	3.88E-02	Zr^{+4}	5.19E+00	Pm-147	2.21E-03	Cm-243	4.50E-07
Mn^{+4}	7.88E-02	O-2	1.59E+01	Sm-151	4.40E-03	Cm-244	4.09E-05
Hg^{+2}	1.95E-02	H2O	1.80E+01	Eu-152	1.06E-05	Cm-245	6.93E-09
Mo^{+6}	3.10E-02	Total	1.00E+02	Eu-154	3.48E-04	Cm-246	4.49E-10
assumed specific gravity	2.0						

2.2 WM-188 Composition

In October 2002, Tank WM-188 contained 211,100 gallons of waste. The tank was sampled and both liquid and solids were analyzed (Johnson 2003a). An estimated 5,000 kg of solids, equivalent to a volume of about 660 gallons, are contained in the tank. Additions to the tank from October 2002 to March 31, 2004 have amounted to 47,000 gallons. An estimated additional 1,600 gallons will be added in April and May 2004. Then, starting in June 2004, Tank WM-187 waste (mostly the heel and wash water from Tank WM-181) will be evaporated and the concentrate added to Tank WM-188. Other additions to WM-188 include NGLW generated from June 2004 through September 2005, and a small amount of waste from the dilute heel in Tank WM-180.

Table 5. Basis for Tank WM-188 waste composition.

	Gallons	Stream Name
Liquid waste in tank October 2002	210,440	WM-188-0
Estimated solids in tank October 2002	660	WM-188-S
Concentrate added through May 2004	48,600	ETS-1
NGLW added June 2004 through Sept 2005	5,500	NGLW-3
Evaporator concentrate from WM-181	16,400	WM-181-0
Evaporator concentrate from final WM-180 heel	70	WM-180-H
Final volume	**281,670**	**WM-188**
Gallons solids	660	WM-188-S
Gallons liquid	281,010	WM-188-L

Table 6 shows the composition of waste in Tank WM-188 waste assuming 5,000 kg of solids. As for Tank WM-187, there is uncertainty in the amount of solids in Tank WM-188. Thus, Table 7 shows composition for the case of no solids (equivalent to the composition of the liquid only), and the case of twice as many solids as shown in Table 6.

In 1999 when Tank WM-188 was last at heel level, the tank was inspected by video and very few solids (~1/4-in) were seen in the tank (Patterson 2000). Since then, the waste that has been added to the tank has been SBW from other tanks that has undergone further concentration by evaporation.

A 236-ml portion of the 2002 WM-188 sample was allowed to settle, and after 7 days, the solids had settled into a sludge layer of about 3.6 ml. The concentration of solids in the sample may not necessarily equal that in the tank, but if they were equal, the sludge in the tank would amount to about 11,000 gallons. Assuming a solids particle density of 2 kg/liter, 5000 kg would occupy about 6% of this volume. The volume fraction of the WM-188 sludge was not measured, but was found to be about 7% for sludge from Tank WM-189.[c]

As was done for Tank WM-187, the concentrations of nitrates shown in Tables 6 and 7 have been adjusted from measured values to achieve an overall charge balance in the total composition. The specific gravity and TOC are based on sample analysis (Johnson, 2003a).

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[c] Batcheller (2003, see Section 3.3.2) calculates the interstitial liquid volume of a 15 ml sample of WM-189 sludge to be 14 ml. Hence the volume of the undissolved solids is approximately 1 ml and the volume fraction of undissolved solids 1/15 = 6.7%. Unpublished results for the February 2004 WM-187 sample show the sludge to be 11 vol % solids, and two measurements of an earlier WM-187 sample give results of 9.4 and 10.5 vol % solids in the sludge.

Table 6. Tank WM-188 waste composition, liquids and solids.

Gallons	281,670		mol/liter		Ci/liter		Ci/liter
SG	1.32	PO_4^{-3}	1.38E-02	Th-232	9.75E-16	Tc-98	3.55E-12
		Pu^{+4}	5.37E-06	Th-234	2.85E-08	Tc-99	2.49E-05
	mol/liter	K^{+}	1.77E-01	Pa-231	1.23E-10	Ru-106	1.31E-06
H+	2.68E+00	Pr^{+4}	1.19E-05	Pa-233	4.03E-06	Rh-102	1.19E-09
Al^{+3}	6.77E-01	Pm^{+3}	1.74E-09	Pa-234m	2.85E-08	Rh-106	1.31E-06
Am^{+4}	8.32E-08	Rh^{+4}	5.14E-06	U-232	2.95E-09	Pd-107	2.27E-08
Sb^{+5}	5.82E-06	Rb^{+}	7.91E-06	U-233	1.18E-10	Cd-113m	4.57E-06
As^{+5}	1.04E-05	Ru^{+3}	2.29E-04	U-234	1.29E-06	In-115	1.39E-16
Ba^{+2}	7.92E-05	Sm^{+3}	7.83E-06	U-235	1.08E-07	Sn-121m	9.20E-08
Be^{+2}	1.88E-05	Se^{+4}	6.92E-06	U-236	5.01E-08	Sn-126	5.77E-07
B^{+3}	2.19E-02	Si^{+4}	1.45E-02	U-237	9.42E-09	Sb-125	2.45E-05
Br^{-}	4.35E-07	Ag^{+}	1.87E-05	U-238	1.53E-08	Sb-126m	5.65E-07
Cd^{+2}	3.32E-03	Na^{+}	1.52E+00	Np-237	4.03E-06	Sb-126	7.91E-08
Ca^{+2}	6.55E-02	Sr^{+2}	9.88E-05	Np-238	8.08E-10	Te-123	5.27E-19
Ce^{+4}	3.50E-05	SO_4^{-2}	3.76E-02	Np-239	2.28E-07	Te-125m	4.33E-06
Cs^{+}	3.66E-05	Tc^{+7}	1.48E-05	Pu-236	3.99E-09	I-129	7.49E-08
Cl^{-}	3.06E-02	Te^{+4}	4.66E-06	Pu-238	6.43E-04	Cs-134	7.62E-05
Cr^{+3}	5.42E-03	Tb^{+4}	3.01E-09	Pu-239	7.31E-05	Cs-135	1.20E-06
Co^{+2}	4.88E-05	Tl^{+3}	3.07E-06	Pu-240	1.47E-05	Cs-137	7.06E-02
Cu^{+2}	7.73E-04	Th^{+4}	3.27E-05	Pu-241	4.08E-04	Ba-137m	6.68E-02
Eu^{+3}	7.21E-07	Sn^{+4}	1.82E-04	Pu-242	1.18E-08	La-138	2.63E-16
F^{-}	3.53E-02	Ti^{+4}	1.39E-04	Pu-244	3.13E-17	Ce-142	4.11E-11
Gd^{+3}	1.86E-04	U^{+4}	4.07E-04	Am-241	6.82E-05	Ce-144	8.80E-07
Ge^{+4}	1.25E-08	V^{+5}	4.16E-05	Am-242m	2.37E-08	Pr-144	8.80E-07
In^{+3}	1.97E-06	Y^{+3}	9.76E-06	Am-242	2.36E-08	Nd-144	2.21E-15
I^{-}	3.61E-06	Zn^{+2}	9.43E-04	Am-243	3.36E-08	Pm-146	7.00E-08
Fe^{+3}	2.56E-02	Zr^{+4}	5.93E-03	Cm-242	4.66E-08	Pm-147	2.39E-04
La^{+3}	1.31E-05	O-2	2.16E-02	Cm-243	3.92E-08	Sm-146	3.80E-13
Pb^{+2}	1.03E-03	H2O	4.55E+01	Cm-244	1.09E-06	Sm-147	1.01E-11
Li^{+}	3.63E-04			Cm-245	4.12E-10	Sm-148	5.21E-17
Mg^{+2}	2.58E-02		g/liter	Cm-246	2.71E-11	Sm-149	4.62E-18
Mn^{+4}	1.66E-02	TOC	0.40			Sm-151	4.71E-04
Hg^{+2}	7.10E-03	UDS	4.69	H-3	1.68E-05	Eu-150	1.98E-11
Mo^{+6}	2.85E-04			Be-10	4.13E-12	Eu-152	3.49E-06
Nd^{+3}	4.22E-05		Ci/liter	C-14	1.69E-10	Eu-154	2.54E-04
Np^{+4}	2.41E-05		(Jan, 2003)	Se-79	7.09E-07	Eu-155	2.26E-04
Ni^{+2}	2.59E-03	Ra-226	1.15E-11	Rb-87	4.03E-11	Gd-152	1.96E-18
Nb^{+5}	1.80E-04	Ac-227	5.42E-11	Sr-90	5.25E-02	Ho-166m	6.33E-11
NO_3^{-}	6.71E+00	Th-230	1.18E-09	Y-90	5.25E-02	Co-60	5.85E-05
Pd^{+4}	3.98E-04	Th-231	2.95E-08	Zr-93	3.05E-06	Ni-63	4.60E-05

Table 7. Tank WM-188 composition without solids and with twice the expected solids.

	No Solids	**Max solids**		**No Solids**	**Max solids**		**No Solids**	**Max solids**		**No Solids**	**Max solids**
Gal	281,670	281,670		mol/liter	mol/liter		Ci/liter	Ci/liter		Ci/liter	Ci/liter
SG	1.31	1.32	PO_4^{-3}	1.21E-03	2.68E-02	Th-232	9.77E-16	9.95E-16	Tc-98	3.56E-12	3.62E-12
			Pu^{+4}	5.39E-06	5.49E-06	Th-234	2.86E-08	2.91E-08	Tc-99	2.39E-05	2.64E-05
	mol/liter	mol/liter	K^{+}	1.76E-01	1.83E-01	Pa-231	1.23E-10	1.26E-10	Ru-106	1.28E-06	1.36E-06
H+	2.68E+00	2.73E+00	Pr^{+4}	1.19E-05	1.22E-05	Pa-233	4.04E-06	4.12E-06	Rh-102	1.19E-09	1.21E-09
Al^{+3}	6.74E-01	6.95E-01	Pm^{+3}	1.75E-09	1.78E-09	Pa-234m	2.86E-08	2.91E-08	Rh-106	1.28E-06	1.36E-06
Am^{+4}	8.34E-08	8.49E-08	Rh^{+4}	5.15E-06	5.25E-06	U-232	2.89E-09	3.07E-09	Pd-107	2.28E-08	2.32E-08
Sb^{+5}	4.71E-06	7.04E-06	Rb^{+}	7.93E-06	8.07E-06	U-233	1.16E-10	1.22E-10	Cd-113m	4.58E-06	4.67E-06
As^{+5}	7.86E-06	1.30E-05	Ru^{+3}	1.71E-04	2.91E-04	U-234	1.27E-06	1.34E-06	In-115	1.39E-16	1.41E-16
Ba^{+2}	7.78E-05	8.24E-05	Sm^{+3}	7.85E-06	7.99E-06	U-235	1.06E-07	1.11E-07	Sn-121m	9.22E-08	9.40E-08
Be^{+2}	1.78E-05	2.02E-05	Se^{+4}	4.37E-06	9.57E-06	U-236	4.91E-08	5.24E-08	Sn-126	5.67E-07	6.00E-07
B^{+3}	2.17E-02	2.26E-02	Si^{+4}	7.79E-04	2.83E-02	U-237	9.34E-09	9.72E-09	Sb-125	1.91E-05	3.04E-05
Br^{-}	4.36E-07	4.44E-07	Ag^{+}	5.80E-06	3.18E-05	U-238	1.51E-08	1.59E-08	Sb-126m	5.67E-07	5.77E-07
Cd^{+2}	3.31E-03	3.40E-03	Na^{+}	1.52E+00	1.57E+00	Np-237	4.04E-06	4.12E-06	Sb-126	7.93E-08	8.08E-08
Ca^{+2}	6.53E-02	6.74E-02	Sr^{+2}	9.79E-05	1.02E-04	Np-238	8.15E-10	8.20E-10	Te-123	5.29E-19	5.38E-19
Ce^{+4}	3.41E-05	3.67E-05	SO_4^{-2}	3.68E-02	3.92E-02	Np-239	2.30E-07	2.31E-07	Te-125m	4.35E-06	4.43E-06
Cs^{+}	3.53E-05	3.87E-05	Tc^{+7}	1.42E-05	1.45E-05	Pu-236	4.05E-09	4.03E-09	I-129	7.36E-08	7.79E-08
Cl^{-}	2.99E-02	3.20E-02	Te^{+4}	4.67E-06	4.76E-06	Pu-238	6.46E-04	6.54E-04	Cs-134	7.56E-05	7.86E-05
Cr^{+3}	5.35E-03	5.62E-03	Tb^{+4}	3.02E-09	3.08E-09	Pu-239	7.32E-05	7.47E-05	Cs-135	1.19E-06	1.25E-06
Co^{+2}	4.81E-05	5.07E-05	Tl^{+3}	1.92E-06	4.27E-06	Pu-240	1.49E-05	1.48E-05	Cs-137	6.96E-02	7.33E-02
Cu^{+2}	7.69E-04	7.96E-04	Th^{+4}	3.28E-05	3.34E-05	Pu-241	4.09E-04	4.17E-04	Ba-137m	6.58E-02	6.94E-02
Eu^{+3}	7.23E-07	7.36E-07	Sn^{+4}	4.70E-05	3.17E-04	Pu-242	1.20E-08	1.19E-08	La-138	2.63E-16	2.68E-16
F^{-}	3.54E-02	3.61E-02	Ti^{+4}	6.65E-05	2.14E-04	Pu-244	3.20E-17	3.13E-17	Ce-142	4.12E-11	4.20E-11
Gd^{+3}	1.85E-04	1.91E-04	U^{+4}	4.02E-04	4.23E-04	Am-241	6.84E-05	6.96E-05	Ce-144	8.64E-07	9.17E-07
Ge^{+4}	1.26E-08	1.28E-08	V^{+5}	4.05E-05	4.36E-05	Am-242m	2.39E-08	2.41E-08	Pr-144	8.64E-07	9.17E-07
In^{+3}	1.98E-06	2.01E-06	Y^{+3}	9.79E-06	9.97E-06	Am-242	2.38E-08	2.40E-08	Nd-144	2.22E-15	2.26E-15
I^{-}	3.62E-06	3.69E-06	Zn^{+2}	9.37E-04	9.71E-04	Am-243	3.37E-08	3.43E-08	Pm-146	7.02E-08	7.15E-08
Fe^{+3}	2.51E-02	2.67E-02	Zr^{+4}	3.34E-03	8.59E-03	Cm-242	4.68E-08	4.76E-08	Pm-147	2.35E-04	2.49E-04
La^{+3}	1.31E-05	1.34E-05	O-2		4.32E-02	Cm-243	3.92E-08	4.02E-08	Sm-146	3.80E-13	3.88E-13
Pb^{+2}	1.03E-03	1.06E-03	H2O	4.56E+01	4.50E+01	Cm-244	1.08E-06	1.12E-06	Sm-147	1.02E-11	1.03E-11
Li^{+}	3.52E-04	3.82E-04				Cm-245	4.12E-10	4.22E-10	Sm-148	5.22E-17	5.32E-17
Mg^{+2}	2.57E-02	2.65E-02		g/liter	g/liter	Cm-246	2.71E-11	2.78E-11	Sm-149	4.63E-18	4.72E-18
Mn^{+4}	1.66E-02	1.70E-02	TOC	0.40	0.41				Sm-151	4.63E-04	4.91E-04
Hg^{+2}	7.12E-03	7.25E-03	UDS	0	9.4	H-3	1.69E-05	1.72E-05	Eu-150	1.98E-11	2.02E-11
Mo^{+6}	2.69E-04	3.06E-04				Be-10	4.14E-12	4.22E-12	Eu-152	3.47E-06	3.60E-06
Nd^{+3}	4.23E-05	4.31E-05		Ci/liter	Ci/liter	C-14	1.66E-10	1.75E-10	Eu-154	2.53E-04	2.60E-04
Np^{+4}	2.42E-05	2.46E-05		(Jan, 2003)	(Jan, 2003)	Se-79	6.03E-07	8.29E-07	Eu-155	2.25E-04	2.33E-04
Ni^{+2}	2.55E-03	2.69E-03	Ra-226	1.13E-11	1.15E-11	Rb-87	4.04E-11	4.12E-11	Gd-152	1.96E-18	2.00E-18
Nb^{+5}	3.11E-05	3.30E-04	Ac-227	5.32E-11	5.42E-11	Sr-90	5.24E-02	5.39E-02	Ho-166m	6.35E-11	6.47E-11
NO_3^{-}	6.71E+00	6.87E+00	Th-230	1.13E-09	1.16E-09	Y-90	5.24E-02	5.39E-02	Co-60	5.83E-05	6.01E-05
Pd^{+4}	3.75E-04	4.30E-04	Th-231	2.89E-08	2.95E-08	Zr-93	3.06E-06	3.11E-06	Ni-63	4.62E-05	4.70E-05

Table 8. Tank WM-188 solids composition.

	Weight percent		Weight percent		Ci/kg		Ci/kg
Al^{+3}	2.28E+00	Ni^{+2}	5.56E-02	C-14	7.27E-10	Eu-155	4.50E-04
Sb^{+5}	2.91E-03	Nb^{+5}	2.96E-01	Co-60	7.75E-05	Th-230	2.71E-09
As^{+5}	4.02E-03	NO_3^-	1.68E+01	Ni-59	2.30E-05	U-232	7.25E-09
Ba^{+2}	4.56E-03	Pd^{+4}	5.40E-02	Ni-63	3.81E-04	U-233	1.25E-10
Be^{+2}	2.01E-04	PO_4^{-3}	2.64E+01	Se-79	2.62E-06	U-234	1.18E-06
B^{+3}	6.47E-02	K^+	1.93E+00	Sr-90	5.51E-02	U-235	8.89E-08
Cd^{+2}	3.38E-02	Ru^{+3}	1.26E-01	Y-90	5.51E-02	U-236	1.35E-07
Ca^{+2}	3.75E-01	Se^{+4}	4.31E-03	Tc-99	2.23E-04	U-238	2.09E-08
Ce^{+4}	3.01E-03	Si^{+4}	8.23E+00	Ru-106	5.66E-06	Np-237	6.41E-07
Cs^+	3.93E-03	Ag^+	2.97E-02	Rh-106	5.66E-06	Pu-236	7.97E-09
Cl^-	5.88E-01	Na^+	5.52E+00	Sn-126	2.47E-06	Pu-238	2.45E-03
Cr^{+3}	9.73E-02	Sr^{+2}	2.20E-03	Sb-125	1.17E-03	Pu-239	3.36E-04
Co^{+2}	1.10E-03	SO_4^{-2}	1.69E+00	I-129	3.20E-07	Pu-240	3.07E-05
Cu^{+2}	8.64E-03	Tl^{+3}	5.03E-03	Cs-134	1.70E-04	Pu-241	1.89E-03
F^-	0.00E+00	Sn^{+4}	3.41E-01	Cs-135	4.61E-06	Pu-242	2.32E-08
Gd^{+3}	3.93E-03	Ti^{+4}	7.47E-02	Cs-137	2.62E-01	Pu-244	1.99E-15
Fe^{+3}	6.86E-01	U^{+4}	3.30E-02	Ba-137m	2.47E-01	Am-241	5.31E-05
Pb^{+2}	2.73E-02	V^{+5}	1.20E-03	Ce-144	3.84E-06	Am-243	2.59E-08
Li^+	1.68E-03	Zn^{+2}	1.15E-02	Pr-144	3.84E-06	Cm-242	5.29E-11
Mg^{+2}	7.20E-02	Zr^{+4}	5.04E+00	Pm-147	1.02E-03	Cm-243	2.71E-08
Mn^{+4}	9.07E-02	O-2	7.36E+00	Sm-151	2.03E-03	Cm-244	1.70E-06
Hg^{+2}	0.00E+00	H2O	2.16E+01	Eu-152	6.89E-06	Cm-245	2.88E-10
Mo^{+6}	3.24E-02	Total	100.00	Eu-154	2.12E-04	Cm-246	1.87E-11
assumed specific gravity		2.0					

The solids composition shown in Table 8 is based on analyses data from a sample of WM-188 waste taken in FY 2003 (see Johnson 2003a). The sample was allowed to settle, the sludge layer then filtered, the solids washed with water and isopropyl alcohol and then dried. The dried solids were fused, dissolved in nitric acid or water and then analyzed using the same techniques as used for the tank liquid.

The elements Sb, As, Be, Ce, Cs, Li, Se, Tl, U and V were not detected in the sample; values shown above are based on detection limits. No analyses for Cl, F or Hg were performed for this sample; values shown above were based on the average of analyses of other tank solids samples. The concentration of water shown in Table 8 is meant to be all hydrated water. No analysis for hydrated water was performed, the value of 21.6% is an estimate based primarily on the concentration of sulfates and phosphates and some assumed hydrate compounds. The concentration of oxides in the solids was calculated by charge balance. Finally, the concentrations of all chemical species except hydrated water were normalized to arrive at the values shown above.

The solids sample was analyzed for twenty radionuclides. Of these twenty, two were not detected (^{59}Ni and ^{95}Zr), and the analytical result for one (^{242}Cm) was negative. Concentrations shown in Table 8 for radionuclides other than these 17 were derived from activities for solids from Tanks WM-182 and WM-183 as published by Swenson (MCS-06-02, 2002). To arrive at these estimates, the activities shown in Table A of MCS-06-02 for Tanks WM-182 and WM-183 were first decayed to January, 2003. The averages of the decayed activity for each radionuclide in the two tanks were then used to calculate ratios. These ratios were then used to estimate activities for Tank WM-188 radionuclides. For example, the activity of ^{135}Cs in WM-188 solids was estimated by multiplying the measured activity of ^{137}Cs in the WM-188 sample by the ratio of ^{135}Cs to ^{137}Cs in Tank WM-182 and WM-183 solids.

2.3 WM-189 Composition

Samples were taken from Tank WM-189 in March 2002. No waste has been added to this tank since that time or is expected to be in the future. Three separate samples of the liquid were taken via airlifting tank waste to the NWCF, where it could be sampled. A sample of tank waste near the bottom of the tank was then taken using the tank steam jet. The sampling procedure, analysis methods and results were reported by Batcheller and Taylor (2003). Table 9 shows the composition of waste in WM-189 with an estimated amount of solids. Table 10 shows the composition of the waste with no solids and with twice the expected amount.

Table 9. WM-189 waste composition, liquids and solids.

Gallons	**279,800**		**mol/liter**		**mol/liter**		**Ci/liter**		**Ci/liter**
SG	1.34	Hg^{+2}	6.45E-03	Y^{+3}	7.01E-06	Pu-238	4.08E-04	Sn-121m	6.61E-08
		Mo^{+6}	3.11E-04	Zn^{+2}	1.08E-03	Pu-239	4.65E-05	Sn-126	4.29E-07
	mol/liter	Nd^{+3}	3.03E-05	Zr^{+4}	5.57E-03	Pu-240	1.03E-05	Sb-125	2.38E-05
H+	2.86E+00	Np^{+4}	1.73E-05	O-2	4.34E-02	Pu-241	4.14E-04	Sb-126m	4.06E-07
Al^{+3}	7.24E-01	Ni^{+2}	2.41E-03	H2O	4.27E+01	Pu-242	8.04E-09	Sb-126	5.69E-08
Am^{+4}	8.94E-08	Nb^{+5}	5.48E-04			Pu-244	6.88E-16	Te-123	3.79E-19
Sb^{+5}	9.81E-06	NO_3^-	7.53E+00		g/liter	Am-241	7.36E-05	Te-125m	3.11E-06
As^{+5}	1.06E-05	Pd^{+4}	5.15E-05	TOC	0.58	Am-242m	1.50E-08	I-129	5.58E-08
Ba^{+2}	5.91E-05	PO_4^{-3}	2.65E-02	UDS	9.4	Am-242	1.50E-08	Cs-134	4.17E-05
Be^{+2}	2.22E-05	Pu^{+4}	3.86E-06			Am-243	2.14E-08	Cs-135	8.93E-07
B^{+3}	2.16E-02	K^+	2.29E-01		Ci/liter	Cm-242	2.97E-08	Cs-137	5.23E-02
Br^-	3.12E-07	Pr^{+4}	8.56E-06		(Jan, 2003)	Cm-243	2.83E-08	Ba-137m	4.95E-02
Cd^{+2}	3.92E-03	Pm^{+3}	1.31E-09	Ra-226	8.10E-12	Cm-244	1.06E-06	La-138	1.89E-16
Ca^{+2}	7.36E-02	Rh^{+4}	3.69E-06	Ac-227	3.81E-11	Cm-245	2.98E-10	Ce-142	2.96E-11
Ce^{+4}	3.73E-05	Rb^+	5.68E-06	Th-230	8.39E-10	Cm-246	1.96E-11	Ce-144	6.56E-07
Cs^+	2.95E-05	Ru^{+3}	2.89E-04	Th-231	2.07E-08			Pr-144	6.56E-07
Cl^-	2.22E-02	Sm^{+3}	5.63E-06	Th-232	7.00E-16	H-3	9.61E-06	Nd-144	1.59E-15
Cr^{+3}	5.84E-03	Se^{+4}	9.76E-06	Th-234	2.05E-08	Be-10	2.97E-12	Pm-146	5.03E-08
Co^{+2}	4.84E-05	Si^{+4}	2.80E-02	Pa-231	8.83E-11	C-14	1.26E-10	Pm-147	1.78E-04
Cu^{+2}	9.70E-04	Ag^+	2.80E-05	Pa-233	2.90E-06	Se-79	6.49E-07	Sm-146	2.73E-13
Eu^{+3}	5.18E-07	Na^+	2.07E+00	Pa-234m	2.05E-08	Rb-87	2.90E-11	Sm-147	7.28E-12
F^-	1.37E-02	Sr^{+2}	1.43E-04	U-232	2.03E-09	Sr-90	3.91E-02	Sm-148	3.74E-17
Gd^{+3}	1.37E-04	SO_4^{-2}	1.08E-01	U-233	8.02E-11	Y-90	3.91E-02	Sm-149	3.32E-18
Ge^{+4}	9.01E-09	Tc^{+7}	7.16E-06	U-234	1.75E-06	Zr-93	2.19E-06	Sm-151	3.51E-04
In^{+3}	1.42E-06	Te^{+4}	7.22E-06	U-235	6.07E-08	Tc-98	2.55E-12	Eu-150	1.42E-11
I^-	2.59E-06	Tb^{+4}	2.17E-09	U-236	7.90E-08	Tc-99	1.20E-05	Eu-152	2.55E-06
Fe^{+3}	2.81E-02	Tl^{+3}	4.34E-06	U-237	6.36E-09	Ru-106	9.73E-07	Eu-154	1.85E-04
La^{+3}	9.41E-06	Th^{+4}	3.48E-05	U-238	4.35E-08	Rh-102	8.52E-10	Eu-155	1.67E-04
Pb^{+2}	1.17E-03	Sn^{+4}	3.12E-04	Np-237	2.90E-06	Rh-106	9.73E-07	Gd-152	1.41E-18
Li^+	4.04E-04	Ti^{+4}	2.20E-04	Np-238	4.71E-10	Pd-107	1.63E-08	Ho-166m	4.55E-11
Mg^{+2}	2.23E-02	U^{+4}	6.69E-04	Np-239	1.33E-07	Cd-113m	3.28E-06	Co-60	3.68E-05
Mn^{+4}	1.95E-02	V^{+5}	2.74E-05	Pu-236	2.78E-09	In-115	9.95E-17	Ni-63	3.13E-05

Table 10. Tank WM-189 composition without solids and with twice the expected solids.

	No Solids	Max solids		No Solids	Max solids		No Solids	Max solids		No Solids	Max solids
Gallons	279,800	279,800		mol/liter	mol/liter		Ci/liter	Ci/liter		Ci/liter	Ci/liter
SG	1.34	1.34	PO_4^{-3}	2.07E-03	5.27E-02	Th-232	7.04E-16	6.97E-16	Tc-98	2.56E-12	2.54E-12
			Pu^{+4}	3.88E-06	3.84E-06	Th-234	2.06E-08	2.04E-08	Tc-99	9.96E-06	1.41E-05
	mol/liter	mol/liter	K^{+}	2.25E-01	2.32E-01	Pa-231	8.88E-11	8.79E-11	Ru-106	9.24E-07	1.02E-06
H+	2.88E+00	2.85E+00	Pr^{+4}	8.60E-06	8.52E-06	Pa-233	2.91E-06	2.88E-06	Rh-102	8.56E-10	8.48E-10
Al^{+3}	7.19E-01	7.28E-01	Pm^{+3}	1.26E-09	1.37E-09	Pa-234m	2.06E-08	2.04E-08	Rh-106	9.24E-07	1.02E-06
Am^{+4}	8.92E-08	8.96E-08	Rh^{+4}	3.71E-06	3.67E-06	U-232	1.97E-09	2.09E-09	Pd-107	1.64E-08	1.63E-08
Sb^{+5}	7.59E-06	1.20E-05	Rb^{+}	5.71E-06	5.65E-06	U-233	7.94E-11	8.10E-11	Cd-113m	3.30E-06	3.27E-06
As^{+5}	5.55E-06	1.56E-05	Ru^{+3}	1.72E-04	4.05E-04	U-234	1.75E-06	1.76E-06	In-115	1.00E-16	9.91E-17
Ba^{+2}	5.62E-05	6.20E-05	Sm^{+3}	5.65E-06	5.60E-06	U-235	6.01E-08	6.12E-08	Sn-121m	6.64E-08	6.58E-08
Be^{+2}	2.02E-05	2.42E-05	Se^{+4}	4.62E-06	1.49E-05	U-236	7.81E-08	7.99E-08	Sn-126	4.08E-07	4.51E-07
B^{+3}	2.12E-02	2.21E-02	Si^{+4}	3.09E-04	5.57E-02	U-237	6.39E-09	6.33E-09	Sb-125	1.28E-05	3.48E-05
Br^{-}	3.14E-07	3.11E-07	Ag^{+}	2.05E-06	5.40E-05	U-238	4.35E-08	4.35E-08	Sb-126m	4.08E-07	4.04E-07
Cd^{+2}	3.91E-03	3.93E-03	Na^{+}	2.06E+00	2.08E+00	Np-237	2.91E-06	2.88E-06	Sb-126	5.71E-08	5.66E-08
Ca^{+2}	7.31E-02	7.42E-02	Sr^{+2}	1.42E-04	1.45E-04	Np-238	4.79E-10	4.62E-10	Te-123	3.81E-19	3.77E-19
Ce^{+4}	3.55E-05	3.92E-05	SO_4^{-2}	1.07E-01	1.10E-01	Np-239	1.35E-07	1.30E-07	Te-125m	3.13E-06	3.10E-06
Cs^{+}	2.68E-05	3.21E-05	Tc^{+7}	5.94E-06	8.39E-06	Pu-236	2.72E-09	2.84E-09	I-129	5.30E-08	5.85E-08
Cl^{-}	2.07E-02	2.37E-02	Te^{+4}	7.26E-06	7.19E-06	Pu-238	3.87E-04	4.30E-04	Cs-134	4.03E-05	4.31E-05
Cr^{+3}	5.69E-03	5.99E-03	Tb^{+4}	2.18E-09	2.16E-09	Pu-239	4.35E-05	4.94E-05	Cs-135	8.54E-07	9.33E-07
Co^{+2}	4.68E-05	4.99E-05	Tl^{+3}	2.03E-06	6.66E-06	Pu-240	1.01E-05	1.06E-05	Cs-137	5.01E-02	5.46E-02
Cu^{+2}	9.62E-04	9.78E-04	Th^{+4}	3.50E-05	3.46E-05	Pu-241	3.98E-04	4.30E-04	Ba-137m	4.74E-02	5.16E-02
Eu^{+3}	5.20E-07	5.15E-07	Sn^{+4}	4.14E-05	5.83E-04	Pu-242	7.85E-09	8.22E-09	La-138	1.90E-16	1.88E-16
F^{-}	1.37E-02	1.36E-02	Ti^{+4}	7.29E-05	3.67E-04	Pu-244	6.73E-16	7.04E-16	Ce-142	2.97E-11	2.94E-11
Gd^{+3}	1.35E-04	1.39E-04	U^{+4}	6.68E-04	6.70E-04	Am-241	7.34E-05	7.37E-05	Ce-144	6.23E-07	6.89E-07
Ge^{+4}	9.05E-09	8.96E-09	V^{+5}	2.53E-05	2.96E-05	Am-242m	1.51E-08	1.50E-08	Pr-144	6.23E-07	6.89E-07
In^{+3}	1.42E-06	1.41E-06	Y^{+3}	7.05E-06	6.98E-06	Am-242	1.50E-08	1.49E-08	Nd-144	1.60E-15	1.58E-15
I^{-}	2.61E-06	2.58E-06	Zn^{+2}	1.07E-03	1.09E-03	Am-243	2.13E-08	2.16E-08	Pm-146	5.05E-08	5.01E-08
Fe^{+3}	2.70E-02	2.91E-02	Zr^{+4}	3.56E-04	1.08E-02	Cm-242	2.98E-08	2.95E-08	Pm-147	1.69E-04	1.87E-04
La^{+3}	9.45E-06	9.37E-06	O-2		8.69E-02	Cm-243	2.82E-08	2.85E-08	Sm-146	2.74E-13	2.71E-13
Pb^{+2}	1.16E-03	1.18E-03	H2O	4.29E+01	4.25E+01	Cm-244	1.05E-06	1.07E-06	Sm-147	7.32E-12	7.25E-12
Li^{+}	3.83E-04	4.25E-04				Cm-245	2.96E-10	2.99E-10	Sm-148	3.76E-17	3.72E-17
Mg^{+2}	2.21E-02	2.24E-02		g/liter	g/liter	Cm-246	1.95E-11	1.97E-11	Sm-149	3.34E-18	3.31E-18
Mn^{+4}	1.95E-02	1.96E-02	TOC	0.59	0.58				Sm-151	3.33E-04	3.69E-04
Hg^{+2}	6.48E-03	6.42E-03	UDS	0	18.9	H-3	9.66E-06	9.57E-06	Eu-150	1.43E-11	1.41E-11
Mo^{+6}	2.80E-04	3.41E-04				Be-10	2.98E-12	2.95E-12	Eu-152	2.50E-06	2.61E-06
Nd^{+3}	3.05E-05	3.02E-05		Ci/liter	Ci/liter	C-14	1.19E-10	1.32E-10	Eu-154	1.84E-04	1.86E-04
Np^{+4}	1.74E-05	1.73E-05		(Jan, 2003)	(Jan, 2003)	Se-79	4.34E-07	8.63E-07	Eu-155	1.63E-04	1.70E-04
Ni^{+2}	2.33E-03	2.49E-03	Ra-226	8.14E-12	8.06E-12	Rb-87	2.91E-11	2.88E-11	Gd-152	1.41E-18	1.40E-18
Nb^{+5}	2.49E-04	8.47E-04	Ac-227	3.83E-11	3.80E-11	Sr-90	3.88E-02	3.95E-02	Ho-166m	4.57E-11	4.53E-11
NO_3^{-}	7.53E+00	7.52E+00	Th-230	8.17E-10	8.60E-10	Y-90	3.88E-02	3.95E-02	Co-60	3.62E-05	3.73E-05
Pd^{+4}	3.61E-06	9.94E-05	Th-231	2.08E-08	2.06E-08	Zr-93	2.20E-06	2.18E-06	Ni-63	3.14E-05	3.11E-05

Based on recent analyses (Batcheller 2003), Tank WM-189 waste has a TOC content of 0.6 g/liter, including 0.16 mg/liter volatile organics and 1.1 mg/liter semi-volatile organics.

Compositions shown in Tables 9 and 10 assume a solids composition equal to that of Tank WM-188, shown in Table 8. A large fraction of the waste in Tanks WM-188 and WM-189 was from the same source, hence it is reasonable that the solids should be similar in composition. Analyses were performed of a solids sample from Tank WM-189 (Batcheller 2003), but the solids were not washed prior to drying and hence included a large fraction (estimated to be about 78% of the total solids) of dissolved solids that crystallized upon drying. A comparison of the tank composition based on the WM-189 solids analysis to what is shown in Table 9 is given in Table 35.

2.4 Newly Generated Liquid Waste (NGLW)

Waste from 24 different sources are projected to be added to Tank Farm tanks or to WM-100, WM-101, and WM-102 as NGLW over the next nine years. Table 11 shows the projected volumes of waste that will be generated from 2004 to 2012. These estimated volumes do not include any dilute aqueous waste generated by a SBW treatment process, or decontamination wastes generated prior to treatment in preparing the NWCF should it be selected as the treatment method. A description of each stream can be found in the Waste Minimization Plan (Demmer 2002).

Table 12 shows typical concentration factors for each of these waste streams and expected volumes after concentration. Table 12 also shows that after concentration only a few streams account for the majority of the waste volume (4 streams account for 79% of the total, 10 streams for 96%, and 14 streams for 99%).

In this section, the composition of eleven streams, amounting to 96.8% of the total as concentrated waste, is first presented. Then, using these compositions, results of modeling the evaporation of these dilute wastes are presented which define compositions and volumes that will need to be treated in the SBW treatment facility.

Table 11. Projected dilute NGLW volumes.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total Dilute
Waste Stream	Gallons	Gallons	Gallons	Gallons	Gallons	Gallons	Gallons	Gallons	Gallons	Gallons
NWCF operations (ETS)	500	500	500	500	0	0	0	0	0	2,000
Tank Farm Vessel Flushes	171,000	0	0	0	0	100,000	50,000	50,000	0	371,000
Tank Farm Line Flushes	3,400	3,400	3,400	3,400	500	500	500	500	500	16,100
Vault Flush	0	0	0	0	14,400	14,400	14,400	14,400	14,400	72,000
Filter Leach (1st leach)	2,389	2,389	2,389	2,389	2,389	2,389	2,389	2,389	2,389	21,504
Filter Leach	9,558	9,558	9,558	9,558	9,558	9,558	9,558	9,558	9,558	86,018
PBF D&D	30,000	0	0	0	0	0	0	0	0	30,000
FAST Operations	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	35,000	315,000
CPP-603 Basin Water	600,000	900,000	0	0	0	0	0	0	0	1,500,000
CPP-603 Operations	10,000	10,000	0	0	0	0	0	0	0	20,000
TAN Pool Water	0	0	750,000	0	0	0	0	0	0	750,000
MTR Canal Water	0	0	0	125,000	0	0	0	0	0	125,000
TAN V-Tank	0	0	0	0	6,000	0	0	0	0	6,000
NWCF Utility Tunnel	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	13,500
CPP-604 Sumps	15,000	15,000	15,000	15,000	3,000	3,000	3,000	3,000	3,000	75,000
Tank Farm Sumps	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	0	240,000
LET&D	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	11,700
LET&D Bottoms	2,500	2,500	2,500	2,500	2,500	2,500	2,500	0	0	17,500
CPP-601 (Lab Drains)	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	180,000
NWCF Decon Facility	32,500	32,500	32,500	32,500	32,500	32,500	32,500	32,500	32,500	292,500
CPP-601/627/640 Deactivation	0	0	0	0	45,000	0	0	0	0	45,000
Misc. Deactivation Rinses	0	0	0	0	0	0	0	4,000	5,000	9,000
TRA-689 Decon Solution	0	0	0	0	0	0	0	35,000	0	35,000
PEW Descale	1,200	1,200	1,200	1,200	400	400	400	400	400	6,800
Misc. Balance of Plant	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	180,000
Total gallons	**814,847**	**1,084,847**	**924,847**	**299,847**	**224,047**	**173,047**	**173,047**	**209,547**	**145,547**	**4,420,622**

Table 12. Initial estimates of concentrated NGLW volumes.

Waste Stream	Typical Concentration Factors PEWE	ETS	Total Volume Dilute	Volume after PEWE	Volume after ETS	% of total concentrated	Rank
			gal	gal	gal		
NWCF Operations (ETS)	1	1	2,000	2,000	2,000	2.48%	8
Tank Farm Vessel Flushes	1	200	371,000	371,000	1,855	2.30%	9
Tank Farm Line Flushes	1	1	16,100	16,100	16,100	20.00%	2
Vault Flush	20	2	72,000	3,600	1,800	2.24%	10
Filter Leach (1st leach)	1	2	21,504	21,504	10,752	13.36%	3
Filter Leach	10	2	86,018	8,602	4,301	5.34%	3
PBF D&D	1000	2	30,000	30	15	0.02%	21
FAST Operations	1000	2	315,000	315	158	0.20%	17
CPP-603 Basin Water	1000	2	1,500,000	1,500	750	0.93%	12
CPP-603 Operations	1000	2	20,000	20	10	0.01%	22
TAN Pool Water	1000	2	750,000	750	375	0.47%	14
MTR Canal Water	1000	2	125,000	125	63	0.08%	19
TAN V-Tank	1000	2	6,000	6	3	0.004%	24
NWCF Utility Tunnel	1000	2	13,500	14	7	0.01%	23
CPP-604 Sumps	1000	2	75,000	75	38	0.05%	20
Tank Farm Sumps	1000	2	240,000	240	120	0.15%	18
LET&D	35	2	11,700	334	167	0.21%	16
LET&D Bottoms	1	1	17,500	17,500	17,500	21.74%	1
CPP-601 (Lab Drains)	35	2	180,000	5,143	2,571	3.19%	6
NWCF Decon Facility	10	2	292,500	29,250	14,625	18.17%	4
CPP-601/627/640 Deactivation	10	2	45,000	4,500	2,250	2.80%	7
Misc. Deactivation Rinses	20	2	9,000	450	225	0.28%	15
TRA-689 Decon Solution	35	2	35,000	1,000	500	0.62%	13
PEW Descale	1	2	6,800	6,800	3,400	4.22%	5
Misc. Balance of Plant	100	2	180,000	1,800	900	1.12%	11
Total gallons			**4,420,622**	**492,658**	**80,484**	**100.00%**	

2.4.1 Compositions of Individual Waste Streams

This section details compositions of individual waste streams.

2.4.1.1 LET&D Bottoms. The Liquid Effluent Treatment and Disposal Facility (LET&D) processes the overhead from the PEW evaporator by fractionation. The fractionator overheads are filtered and released to the atmosphere. The fractionator bottoms is concentrated nitric acid with small concentrations of halides and metals. Samples of LET&D bottoms were taken in 1999 and 2000 from the LET&D bottoms tank, WLL-195, and are reported in the Balance of Plant Analysis Report (Nenni 2002). The composition of LET&D bottoms, shown in Table 13, is largely based on these analyses.

Table 13. Estimated LET&D bottoms composition.

	Mol/liter	
H+	1.21E+01	
Al^{+3}	5.61E-02	
Sb^{+5}	6.92E-07	1
As^{+5}	1.62E-06	1
Ba^{+2}	9.77E-07	
Be^{+2}	8.65E-07	
B^{+3}	2.10E-04	2
Cd^{+2}	1.89E-07	1
Ca^{+2}	7.44E-04	2
Cl^{-}	6.57E-03	2
Cr^{+3}	1.70E-03	
Co^{+2}	1.75E-04	
Cu^{+2}	8.54E-05	
F^{-}	7.16E-03	1
Fe^{+3}	2.92E-04	2
Pb^{+2}	4.62E-07	1
Mn^{+4}	5.83E-05	
Hg^{+2}	2.34E-04	
Ni^{+2}	1.94E-03	
NO_3^{-}	1.23E+01	3
PO_4^{-3}	7.49E-05	2
K^{+}	2.51E-03	2
Se^{+4}	1.27E-06	1
Ag^{+}	1.91E-07	1
Na^{+}	2.40E-02	2
S^{+6}	1.09E-03	2
Tl^{+3}	5.75E-07	1
U^{+4}	5.68E-07	1
V^{+5}	1.67E-06	
Zn^{+2}	1.50E-05	
Zr^{+4}	2.91E-06	2
	g/liter	
UDS	2.22E-02	
TIC	4.47E-02	
TOC	1.41E-02	

1. Gray shading indicates data contains flags, typically below detection limits or detected in blank

2. Red shading indicates value was estimated based on concentrations of other known species and the concentration of the unknown species in SBW

3. Blue shading indicates that value was obtained by charge balance

No shading indicates the average of analytical data for three samples. Data points with qualifying flags were excluded from the averages.

Estimates of species that were not analyzed were obtained by multiplying the ratio of the concentration of a given species in SBW by the average ratio of a representative species in the LET&D bottoms to the concentration of these same species in SBW. To estimate the concentration of chloride, the fluoride ratio was used. The other estimated species are all nonvolatile and the average ratio for barium, manganese, and zinc was used to estimate the nonvolatile species.

If the calciner is in operation, the LET&D bottoms can be used as make-up acid for scrub solution. It can also be used in the filter leach operation.

2.4.1.2 Tank Farm Line Flushes. This waste is generated when Tank Farm lines are flushed to reduce radiation fields to allow hands-on maintenance work. This waste continues to be generated during regular maintenance and testing of line integrity, and prior to valve box upgrades. This waste stream should be reduced to a minimum after the valve box upgrades are completed in FY 2006. The composition of Tank Farm line flushes was assumed equal to the average SBW composition as of September 30, 2002.

2.4.1.3 Filter Leach. This waste is generated from preparing spent HEPA filters for disposal. As of 2004, approximately 50 filters await treatment. The filter leach composition, shown in Table 14, is based on the analyses of five samples from NWCF Decontamination Tanks NCD-123 and NCD-129 taken in 1999 and 2001. The data for these samples is compiled in the Balance of Plant Analysis Report (Nenni 2002). Concentrations shown in Table 14 are averages of data and estimates for species not analyzed. The ratio of concentration of a species in the filter leach waste to the concentration of the same species in SBW, averaged for all species measured in filter leach samples, was used to estimate concentrations of non-analyzed species.

Table 14. Estimated filter leach composition.

	Mol/liter		
H^+	5.45E-01		
Al^{+3}	1.83E-03		
Sb^{+5}	5.54E-06		1. Gray shading indicates data contains flags, typically below detection limits or detected in blank
As^{+5}	1.49E-06	1	
Ba^{+2}	8.49E-06		
Be^{+2}	1.33E-07	1	
B^{+3}	6.35E-04	2	2. Red shading indicates value was estimated based on concentrations of other known species and the concentration of the unknown species in SBW
Cd^{+2}	1.34E-06		
Ca^{+2}	2.25E-03	2	
Cl^-	8.54E-04	2	
Cr^{+3}	6.08E-05		
Co^{+2}	3.75E-07	1	3. Blue shading indicates that value was obtained by charge balance
Cu^{+2}	1.96E-05		
F^-	2.15E-03	1	
Fe^{+3}	8.84E-04	2	No shading indicates the average of analytical data for five samples. Data points with qualifying flags were excluded from the averages.
Pb^{+2}	8.45E-06		
Mn^{+4}	2.11E-04		
Hg^{+2}	4.13E-06		
Ni^{+2}	2.86E-05		
NO_3^-	6.57E-01	3	
PO_4^{-3}	2.26E-04	2	
K^+	7.60E-03	2	
Se^{+4}	1.33E-06	1	
Ag^+	7.12E-07	1	
Na^+	7.26E-02	2	
S^{+6}	3.31E-03	2	
Tl^{+3}	5.79E-07	1	
U^{+4}	1.16E-06	1	
V^{+5}	8.42E-07	1	
Zn^{+2}	1.38E-04		
Zr^{+4}	8.79E-06	2	
	g/liter		
UDS	1.50E-02		
TIC	5.88E-02		
TOC	7.03E-01		

2.4.1.4 NWCF Decon Facility. The NWCF Decon Facility waste is generated from decontamination of equipment, treatment of debris, and collection of Utility Tunnel water. Compositional data from 1997 for the NWCF Decon Facility Waste is contained in *Supporting Information for the INEEL Liquid Waste Management Plan* (Tripp 1998). The data include low, average, and high concentration values for six chemical species plus TIC, TOC and UDS. Averages are based on 6 to 20 data points depending on the component. Table 15 shows these averages plus estimates for other species. Estimates were based either on the average SBW or the Process Equipment Waste Evaporator (PEWE) descale composition. Estimates based on SBW were calculated by multiplying the SBW concentration for that specie by the average ratio of decon facility Al and U concentration to SBW Al and U concentration. Since the makeup NWCF Decon solution uses the same chemicals as the PEWE descale (see Section

2.4.1.5), concentrations of the major metal species in the chemicals (Na, K, Cr, and Mn) were assumed the same for the NWCF Decon Facility waste as for the PEWE Descale waste. Table 15 shows the estimated composition of the NWCF Decon Facility waste.

Table 15. Estimated NWCF Decon Facility composition.

	Mol/liter	
H+	7.41E-01	
Al^{+3}	1.23E-02	
Sb^{+5}	4.29E-07	2
As^{+5}	2.80E-06	2
Ba^{+2}	8.47E-07	2
Be^{+2}	2.36E-07	2
B^{+3}	2.71E-04	2
Cd^{+2}	4.14E-05	2
Ca^{+2}	9.59E-04	2
Cl^{-}	1.34E-03	
Cr^{+3}	1.16E-03	1
Co^{+2}	5.48E-07	2
Cu^{+2}	1.30E-05	2
F^{-}	6.21E-03	
Fe^{+3}	3.77E-04	2
Pb^{+2}	1.84E-05	2
Mn^{+4}	6.12E-03	1
Hg^{+2}	2.17E-05	
Ni^{+2}	3.03E-05	2
NO_3^{-}	1.45E+00	3
PO_4^{-3}	9.65E-05	
K^{+}	1.17E-01	1
Se^{+4}	8.19E-07	2
Ag^{+}	2.97E-08	2
Na^{+}	5.25E-01	1
S^{+6}	9.99E-04	
Tl^{+3}	2.29E-07	2
U^{+4}	5.55E-06	
V^{+5}	5.42E-06	2
Zn^{+2}	1.61E-05	2
Zr^{+4}	3.75E-06	2
	g/liter	
UDS	0.79	
TIC		
TOC	0.67	

1. Green shading indicates estimate based on PEWE descale makeup formulation.

2. Red shading indicates value was estimated based on concentrations of other known species and the concentration of the unknown species in SBW

3. Blue shading indicates that value was obtained by charge balance

No shading indicates the average of analytical data.

2.4.1.5 *PEWE Descale.* During operation of the PEWE, a silicate scale builds up on the reboiler heating surface. PEWE descale waste is generated when this scale is removed. The PEWE descale waste composition is based on the following make-up formulation given in *Supporting Information for the INEEL Liquid Waste Management Plan* (Tripp 1998):

- 300 gallons TURCO ARR diluted with water to 2 lb/gal (TURCO ARR assumed to be 70 wt % NaOH, 15 wt % triethanolamine, 5 wt % diethanolamine and 5 wt % kerosene)
- 300 gallons TURCO 4502 diluted with water to 0.5 lb/gal (TURCO 4502 assumed to be 77 wt % KOH, 20 wt % $KMnO_4$, 3 wt % K_2CrO_3)

- 300 gal oxalic acid solution at 0.5 lb oxalic acid per gallon
- 300 gal 6 N HNO_3.

Table 16 lists the composition calculated using the above formulation.

Table 16. PEWE descale composition.

	mol/liter
H^+	1.22E-01
NO_3^-	7.92E-01
K^+	1.17E-01
Mn^{+7}	6.12E-03
Cr^{+6}	1.16E-03
Na^+	5.25E-01
	g/liter
Oxalic acid	7.50
Kerosene	1.50
TEA	4.50
DEA	1.50
TOC	14.99

2.4.1.6 CPP-601 – Lab Drains. This waste is generated by Analytical Laboratory operations, CPP-601 sumps, and pilot plant operations. Nenni (2002) reports analytical data for sixteen samples from the CPP-601 Deep Tanks, and averages of these data are shown in Table 17. Additional data from earlier samples are available in Tripp (1998) but were not used in calculating the composition below. Table 17 also shows the composition range of this waste stream.

Table 17. CPP-601 Deep Tank waste composition.

		Range of concentration Relative to average		
	Mol/liter	Max/Ave	Min/Ave	
H+	3.57E-01	+96%	-63%	1
Al^{+3}	4.28E-03	+340%	-81%	
Sb^{+5}	3.30E-07	+159%	-90%	1
As^{+5}	2.61E-07	+205%	-80%	1
Ba^{+2}	1.35E-06	+270%	-62%	
Be^{+2}	5.89E-07	+354%	-81%	
B^{+3}	1.15E-04			2
Cd^{+2}	1.54E-06	+323%	-77%	
Ca^{+2}	4.08E-04			2
Cl^{-}	2.97E-03	+20%	-20%	
Cr^{+3}	1.77E-05	+111%	-53%	
Co^{+2}	1.13E-06	+173%	-47%	
Cu^{+2}	1.11E-05	+60%	-59%	
F^{-}	1.15E-03	+111%	-40%	1
Fe^{+3}	1.60E-04			2
Pb^{+2}	3.28E-06	+306%	-80%	
Mn^{+4}	1.46E-05	+103%	-54%	
Hg^{+2}	1.14E-05	+206%	-89%	
Ni^{+2}	9.09E-06	+60%	-44%	
NO_3^{-}	3.86E-01			3
PO_4^{-3}	4.11E-05			2
K^{+}	1.38E-03			2
Se^{+4}	1.73E-07	+96%	-77%	1
Ag^{+}	5.15E-07	+640%	-92%	1
Na^{+}	1.32E-02			2
S^{+6}	5.99E-04			2
Tl^{+3}	7.87E-08	+77%	-72%	1
U^{+4}	1.06E-06	+97%	-44%	
V^{+5}	1.92E-07	+139%	-79%	1
Zn^{+2}	2.99E-05	+382%	-68%	
Zr^{+4}	1.59E-06			2
	g/liter			
UDS	1.05E-01	+185%	-97%	
TIC	1.90E-02	+145%	-82%	1
TOC	1.24E-01	+113%	-65%	

1. Gray shading indicates data contains flags, typically below detection limits or detected in blank

2. Red shading indicates value was estimated based on concentrations of other known species and the concentration of the unknown species in SBW

3. Blue shading indicates that value was obtained by charge balance

No shading indicates the average of analytical data for sixteen samples. Data points with qualifying flags were excluded from the averages.

2.4.1.7 *CPP-601/627/640 Deactivation Waste.* Table 18 shows the composition of deactivation wastes from CPP-601, CPP-627, and CPP-640. Concentrations are taken from *Supporting Information for the INEEL Liquid Waste Management Plan* (Tripp, 1998) and are averages of 4 to 26 data points, depending on the chemical specie.

Table 18. CPP-601/627/640 deactivation waste composition.

	Mol/liter	
$H+$	4.58E-02	
Al^{+3}	7.18E-04	
Sb^{+5}	4.27E-08	Red shading indicates value was estimated based on concentrations of other known species and the concentration of the unknown species in SBW.
As^{+5}	2.02E-08	
Ba^{+2}	2.92E-08	
Be^{+2}	1.28E-08	
B^{+3}	2.69E-05	
Cd^{+2}	3.85E-07	No shading indicates the average of analytical data for 4-26 samples.
Ca^{+2}	9.53E-05	
Cl^{-}	1.24E-04	
Cr^{+3}	1.06E-06	
Co^{+2}	5.45E-08	
Cu^{+2}	1.29E-06	
F^{-}	7.53E-05	
Fe^{+3}	3.75E-05	
Pb^{+2}	1.51E-07	
Mn^{+4}	2.63E-05	
Hg^{+2}	6.48E-07	
Ni^{+2}	3.12E-06	
NO_3^{-}	4.92E-02	
PO_4^{-3}	9.60E-06	
K^{+}	9.44E-05	
Se^{+4}	2.18E-08	
Ag^{+}	2.19E-08	
Na^{+}	6.26E-04	
S^{+6}	5.62E-05	
Tl^{+3}	2.28E-08	
U^{+4}	2.24E-09	
V^{+5}	5.39E-07	
Zn^{+2}	1.60E-06	
Zr^{+4}	3.73E-07	
	g/liter	
UDS	1.75E-02	
TIC		
TOC	8.51E-03	

2.4.1.8 NWCF Operations – ETS. This waste has been called "Deep Recycle" in the past. When the calciner is not operating, the waste is generated by the Evaporator Tank System, primarily as condensate from ETS off-gas. Table 19 shows an estimated composition of this waste. The composition is based on analysis of 13 samples from the NWCF Fluoride Hot Sump Tank, NCC-119, taken from December 1998 to March 2000, plus daily logs of NWCF scrub composition from May 14, 1998 to April 8, 1999 and from March 7, 2000 to May 28, 2000. This composition may not be applicable to waste generation in the future if the calciner is not operating. For concentrations derived solely from NCC-119 analyses, Table 19 shows the standard deviation of the data points.

Table 19. Estimated NWCF Operation – deep recycle waste composition.

	Mol/liter	Standard deviation Mol/liter	
H^+	2.74		4
Al^{+3}	8.41E-01		4
Sb^{+5}	6.12E-06		2
As^{+5}	5.17E-05	4.8E-05	1
Ba^{+2}	6.63E-06	5.5E-06	1
Be^{+2}	7.73E-06	6.7E-06	1
B^{+3}	3.86E-03		2
Cd^{+2}	3.84E-04	4.3E-04	
Ca^{+2}	1.37E-02		2
Cl^-	0.0615		4
Cr^{+3}	9.24E-04	8.3E-04	
Co^{+2}	9.33E-06	9.2E-06	1
Cu^{+2}	5.16E-05	4.0E-05	1
F^-	6.11E-02	6.4E-02	1
Fe^{+3}	5.37E-03		2
Pb^{+2}	1.38E-04	1.7E-04	
Mn^{+4}	1.48E-03	1.4E-03	
Hg^{+2}	8.74E-02	4.9E-02	4
Ni^{+2}	2.30E-04	1.5E-04	
NO_3^-	5.99		3
PO_4^{-3}	1.38E-03		2
K^+	4.62E-02		2
Se^{+4}	1.17E-05		2
Ag^+	1.48E-06	1.0E-06	1
Na^+	4.41E-01		2
S^{+6}	2.01E-02		2
Tl^{+3}	3.27E-06		2
U^{+4}	2.91E-05	2.5E-05	
V^{+5}	2.75E-06	7.9E-07	
Zn^{+2}	1.32E-04	1.0E-04	1
Zr^{+4}	5.34E-05		2
	g/liter		
UDS	6.31		
TIC			
TOC	0.13		

1. Gray shading indicates data contains flags, typically below detection limits or detected in blank

2. Red shading indicates value was estimated based on concentrations of other known species and the concentration of the unknown species in SBW

3. Blue shading indicates that value was obtained by charge balance

4. Green shading indicates value is an average based on logs of scrub composition

No shading indicates the average of analytical data for thirteen samples.

2.4.1.9 Tank Farm Vessel Flushes. The composition of Tank Farm vessel flush is equivalent to the composition of waste in the vessel being flushed diluted by the volume of water used to flush the tank. Tanks WM-180, WM-181, WM-103, WM-104, WM-105, and WM-106 are scheduled to be flushed in 2004. Then in the 2010-2012 time period, Tanks WM-187, WM-188, and WM-189 will be flushed after being emptied of waste.

2.4.1.10 Vault Flush. The composition of vault flush waste, after concentration by a factor of 40, was assumed equal to the average composition of SBW as of September 30, 2002.

2.4.1.11 CPP-603 Basin Water. This waste stream is created from emptying the water in the CPP-603 basins when they are taken out of service. Concentrations for most species are taken from Supporting Information for the INEEL Liquid Waste Management Plan (Tripp 1998); others were estimated based on the average SBW composition and the ratio of total dissolved solids in the CPP-603 basin water to that in SBW.

Table 20. Estimated CPP-603 Basin water composition.

	Mol/liter	
H+	1.00E-08	
Al^{+3}	4.15E-06	
Sb^{+5}	2.12E-09	2
As^{+5}	8.47E-08	2
Ba^{+2}	4.28E-11	
Be^{+2}	7.65E-09	2
B^{+3}	4.25E-06	
Cd^{+2}	6.06E-11	
Ca^{+2}	3.37E-04	
Cl^{-}	1.35E-03	
Cr^{+3}	1.45E-07	1
Co^{+2}	4.46E-08	1
Cu^{+2}	7.43E-08	1
F^{-}	1.10E-05	
Fe^{+3}	3.92E-07	
Pb^{+2}	1.45E-11	
Mn^{+4}	1.91E-08	
Hg^{+2}	2.49E-06	2
Ni^{+2}	9.85E-08	1
NO_3^{-}	2.56E-03	
PO_4^{-3}	2.86E-06	2
K^{+}	7.55E-05	
Se^{+4}	7.26E-11	
Ag^{+}	2.65E-09	2
Na^{+}	3.91E-03	4
S^{+6}	3.45E-05	2
Tl^{+3}	2.39E-11	
U^{+4}	2.99E-11	
V^{+5}	2.00E-11	
Zn^{+2}	1.67E-07	
Zr^{+4}	6.70E-07	2
	g/liter	
UDS	1.40E-03	2
TIC	5.91E-02	3
TOC	2.64E-06	

1. Gray shading indicates data contains flags, typically below detection limits or detected in blank

2. Red shading indicates value was estimated based on the average SBW concentration and the ratio of total dissolved solids (TDS) in the waste to TDS in SBW

3. Blue shading indicates that value was obtained by charge balance

4. Green shading indicates value was determined by the measured TDS in the waste

No shading indicates results from samples taken in 1995 and 1998.

2.4.2 Composition of Combined Newly Generated Liquid Waste

The compositions shown in Section 2.4.1 for NGLW streams were used along with results of ASPEN simulations of evaporation of these streams to calculate NGLW added to Tank Farm tanks in 2004-5 and collected in WM-100, WM-101, and WM-102 in 2005-2012.

Tables 1 and 5 show three additions of NGLW to Tanks WM-187 and WM-188. "NGLW-1" includes NGLW streams generated February through June 2004. Five NGLW streams make up 96 volume percent of this waste. Using the dilute compositions shown in Section 2.4.1 for these five streams, evaporation of the combined waste was simulated using an Aspen Plus model. The simulation showed that the waste could be concentrated by a factor of 79. The resulting concentrate composition was expanded in components by assuming the average SBW concentration, adjusted by the ratio of total dissolved solids in the concentrated NGLW to total dissolved solids in average SBW, for species not shown in NGLW composition slates, such as radionuclides. The simulation feed volume was based on $5/12^{ths}$ (5 months) of the 2004 NGLW generation rate. The simulation concentrate volume was divided by the factor 0.96 to account for the other NGLW streams that will be part of this waste.

A similar procedure was used to calculate the composition of stream "NGLW-2." NGLW-2 includes the same streams as NGLW-1 generated July 2004 through September 2005. The 2005 generation volumes of these streams was used to determine a combined composition, and the 2005 volume adjusted by the factor 15/12. Simulation of evaporation of this waste showed that a concentration factor of 153 could be obtained. This factor is higher than that obtained for NGLW-1 because it contains a higher fraction of CPP-603 basin water, a more dilute waste.

The third NGLW waste added to the Tank Farm, "NGLW-3," is a blend of NGLW streams that are not concentrated by evaporation. This waste consists of about 4,800 gal of Tank Farm line flushes and 700 gal of NWCF Operations waste.

Compositions and volumes of the above three NGLW streams were used in the calculation of the final composition of Tanks WM-187 and WM-188. Additional calculations were made to estimate the composition of NGLW generated after 2005. The steps involved in these calculations are outlined below:

1. Based on projected waste generation volumes and compositions for these wastes shown in Section 2.4.1, a blended composition was calculated for each year, 2005 through 2012.
2. These blended compositions and dilute volumes were input into an Aspen Plus evaporation model, simulating concentration of the waste for each year to a 1.3 specific gravity endpoint.
3. Based on the predicted simulation condensate volume and acid content, the amount of LET&D bottoms that would be generated was calculated.
4. The predicted bottoms volume was adjusted to account for minor NGLW streams not included in the simulation.
5. The calculated LET&D bottoms, simulated evaporator concentrate, and estimated quantities of NGLW streams that are not evaporated were combined to obtain total, concentrated NGLW volumes and compositions for each year.

These NGLW compositions are shown in Table 21. Also shown in Table 21 is an estimate of the composition of the present waste in WM-100, WM-101 and WM-102. This estimate is based on compositions and volumes of dilute NGLW waste streams generated 1998-2003. Table 22 shows the composition of NGLW as of the end of 2010 and 2012.

Table 21. Estimated NGLW composition by year.

Year	**Initial** Inventory	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Gallons	12,100	11,348	10,855	6,974	7,285	7,285	9,218	7,116
	mol/liter	mol/liter	mol/liter	mol/liter	mol/liter	mol/liter	mol/liter	mol/liter
H^{+}	2.85E+00	3.41E+00	3.38E+00	3.89E+00	3.92E+00	3.92E+00	3.53E+00	4.06E+00
Al^{+3}	3.70E-01	3.06E-01	3.15E-01	1.66E-01	1.50E-01	1.50E-01	2.50E-01	1.31E-01
Sb^{+5}	1.07E-05	9.67E-06	9.54E-06	1.31E-05	1.20E-05	1.20E-05	1.18E-05	1.24E-05
As^{+5}	3.25E-05	6.02E-05	6.22E-05	2.78E-05	2.61E-05	2.61E-05	2.28E-05	2.70E-05
Ba^{+2}	1.90E-05	3.46E-05	3.50E-05	2.96E-05	2.77E-05	2.77E-05	3.56E-05	2.66E-05
Be^{+2}	5.53E-06	7.11E-06	7.26E-06	4.95E-06	4.56E-06	4.56E-06	6.63E-06	4.20E-06
B^{+3}	3.54E-03	7.77E-03	7.97E-03	5.00E-03	4.55E-03	4.55E-03	7.16E-03	4.06E-03
Cd^{+2}	3.15E-04	9.96E-04	1.03E-03	5.12E-04	4.82E-04	4.82E-04	8.73E-04	4.04E-04
Ca^{+2}	1.25E-02	2.61E-02	2.67E-02	1.72E-02	1.56E-02	1.56E-02	2.42E-02	1.40E-02
Cl^{-}	4.25E-02	1.65E-02	1.69E-02	1.04E-02	1.01E-02	1.01E-02	1.22E-02	9.67E-03
Cr^{+3}	4.46E-03	5.54E-03	5.51E-03	6.44E-03	5.98E-03	5.98E-03	6.41E-03	6.04E-03
Co^{+2}	9.16E-06	3.29E-05	3.29E-05	4.30E-05	3.30E-05	3.30E-05	4.30E-05	3.23E-05
Cu^{+2}	1.23E-04	3.49E-04	3.57E-04	2.42E-04	2.18E-04	2.18E-04	3.34E-04	1.97E-04
F^{-}	4.84E-02	3.39E-02	3.38E-02	3.67E-02	3.57E-02	3.57E-02	3.21E-02	3.53E-02
Fe^{+3}	4.92E-03	1.05E-02	1.08E-02	6.85E-03	6.23E-03	6.23E-03	9.73E-03	5.58E-03
Pb^{+2}	1.44E-04	4.61E-04	4.74E-04	2.50E-04	2.35E-04	2.35E-04	4.11E-04	2.01E-04
Mn^{+4}	2.18E-02	2.47E-02	2.45E-02	3.09E-02	2.89E-02	2.89E-02	2.94E-02	2.95E-02
Hg^{+4}	3.02E-02	5.48E-03	5.71E-03	6.83E-04	6.64E-04	6.64E-04	1.23E-03	5.31E-04
Ni^{+2}	2.66E-04	9.86E-04	1.00E-03	8.27E-04	6.83E-04	6.83E-04	1.03E-03	6.27E-04
NO_3^{-}	6.70E+00	7.51E+00	7.49E+00	8.09E+00	7.84E+00	7.84E+00	7.95E+00	7.97E+00
PO_4^{-3}	1.25E-03	2.46E-03	2.51E-03	1.67E-03	1.51E-03	1.51E-03	2.29E-03	1.37E-03
K^{+}	4.31E-01	4.44E-01	4.37E-01	5.86E-01	5.51E-01	5.51E-01	5.42E-01	5.66E-01
Se^{+4}	9.01E-06	6.97E-06	6.97E-06	7.62E-06	6.98E-06	6.98E-06	7.55E-06	7.03E-06
Ag^{+}	2.88E-06	3.55E-06	3.57E-06	3.56E-06	3.22E-06	3.22E-06	3.81E-06	3.16E-06
Na^{+}	2.09E+00	2.37E+00	2.35E+00	2.83E+00	2.65E+00	2.65E+00	2.76E+00	2.69E+00
S^{+6}	1.67E-02	3.01E-02	3.08E-02	2.03E-02	1.87E-02	1.87E-02	2.81E-02	1.71E-02
Tl^{+3}	2.83E-06	2.11E-06	2.09E-06	2.66E-06	2.34E-06	2.34E-06	2.40E-06	2.39E-06
U^{+4}	3.83E-05	1.58E-04	1.63E-04	8.09E-05	7.65E-05	7.65E-05	1.40E-04	6.39E-05
V^{+5}	2.46E-05	1.28E-04	1.32E-04	7.12E-05	6.40E-05	6.40E-05	1.15E-04	5.39E-05
Zn^{+2}	3.48E-04	5.85E-04	5.92E-04	5.22E-04	4.82E-04	4.82E-04	6.08E-04	4.65E-04
Zr^{+4}	6.13E-05	4.42E-04	4.58E-04	1.92E-04	1.80E-04	1.80E-04	3.75E-04	1.39E-04
	g/liter	g/liter	g/liter	g/liter	g/liter	g/liter	g/liter	g/liter
UDS	5.3	3.7	3.7	4.3	4.0	4.0	3.8	4.1
TOC	4.5	4.9	4.8	5.6	5.2	5.2	4.9	5.4

Table 22. Estimated composition of combined generated waste.

Year	2010	2012		2010	2012		2010	2012		2010	2012
Gal	55,850	72,180		mol/liter	mol/liter		Ci/liter	Ci/liter		Ci/liter	Ci/liter
SG	1.33	1.34	PO_4^{-3}	6.87E-03	6.96E-03	Th-232	8.97E-16	9.10E-16	Tc-98	2.29E-12	2.32E-12
			Pu^{+4}	5.11E-06	5.18E-06	Th-234	2.62E-08	2.66E-08	Tc-99	1.30E-05	1.31E-05
	mol/liter	mol/liter	K^{+}	4.85E-01	5.01E-01	Pa-231	1.13E-10	1.15E-10	Ru-106	1.18E-06	1.19E-06
H+	3.48E+00	3.54E+00	Pr^{+4}	1.10E-05	1.11E-05	Pa-233	3.71E-06	3.76E-06	Rh-102	1.09E-09	1.11E-09
Al^{+3}	2.63E-01	2.49E-01	Pm^{+3}	1.60E-09	1.63E-09	Pa-234m	2.62E-08	2.66E-08	Rh-106	1.18E-06	1.19E-06
Am^{+4}	7.65E-08	7.76E-08	Rh^{+4}	4.73E-06	4.79E-06	U-232	2.52E-09	2.55E-09	Pd-107	2.09E-08	2.12E-08
Sb^{+5}	1.09E-05	1.12E-05	Rb^{+}	7.28E-06	7.38E-06	U-233	1.01E-10	1.03E-10	Cd-113m	4.21E-06	4.27E-06
As^{+5}	4.17E-05	3.78E-05	Ru^{+3}	1.89E-04	1.92E-04	U-234	1.73E-06	1.75E-06	In-115	1.28E-16	1.29E-16
Ba^{+2}	2.89E-05	2.95E-05	Sm^{+3}	7.21E-06	7.31E-06	U-235	8.07E-08	8.18E-08	Sn-121m	8.47E-08	8.59E-08
Be^{+2}	5.86E-06	5.79E-06	Se^{+4}	7.50E-06	7.46E-06	U-236	7.88E-08	7.99E-08	Sn-126	5.20E-07	5.28E-07
B^{+3}	5.71E-03	5.73E-03	Si^{+4}	5.62E-04	5.70E-04	U-237	8.15E-09	8.27E-09	Sb-125	1.71E-05	1.73E-05
Br^{-}	4.00E-07	4.06E-07	Ag^{+}	3.33E-06	3.37E-06	U-238	4.01E-08	4.07E-08	Sb-126m	5.20E-07	5.28E-07
Cd^{+2}	6.60E-04	6.62E-04	Na^{+}	2.44E+00	2.50E+00	Np-237	3.71E-06	3.76E-06	Sb-126	7.28E-08	7.39E-08
Ca^{+2}	1.94E-02	1.95E-02	Sr^{+2}	1.46E-04	1.48E-04	Np-238	2.96E-10	3.00E-10	Te-123	4.85E-19	4.92E-19
Ce^{+4}	4.82E-05	4.89E-05	SO_4^{-2}	2.32E-02	2.32E-02	Np-239	8.34E-08	8.46E-08	Te-125m	3.99E-06	4.05E-06
Cs^{+}	3.07E-05	3.12E-05	Tc^{+7}	7.72E-06	7.83E-06	Pu-236	2.89E-09	2.93E-09	I-129	6.64E-08	6.73E-08
Cl^{-}	1.98E-02	1.78E-02	Te^{+4}	5.81E-06	5.89E-06	Pu-238	5.66E-04	5.74E-04	Cs-134	5.17E-05	5.24E-05
Cr^{+3}	5.53E-03	5.69E-03	Tb^{+4}	2.77E-09	2.81E-09	Pu-239	7.06E-05	7.16E-05	Cs-135	1.09E-06	1.10E-06
Co^{+2}	2.90E-05	3.11E-05	Tl^{+3}	2.39E-06	2.39E-06	Pu-240	1.07E-05	1.08E-05	Cs-137	6.39E-02	6.48E-02
Cu^{+2}	2.54E-04	2.59E-04	Th^{+4}	2.69E-05	2.73E-05	Pu-241	3.42E-04	3.46E-04	Ba-137m	6.04E-02	6.13E-02
Eu^{+3}	6.63E-07	6.73E-07	Sn^{+4}	3.51E-05	3.56E-05	Pu-242	8.54E-09	8.66E-09	La-138	2.42E-16	2.45E-16
F^{-}	3.79E-02	3.69E-02	Ti^{+4}	8.33E-05	8.45E-05	Pu-244	2.29E-17	2.32E-17	Ce-142	3.79E-11	3.84E-11
Gd^{+3}	2.15E-04	2.18E-04	U^{+4}	1.02E-04	1.03E-04	Am-241	6.30E-05	6.39E-05	Ce-144	7.94E-07	8.05E-07
Ge^{+4}	1.15E-08	1.17E-08	V^{+5}	8.27E-05	8.40E-05	Am-242m	1.36E-08	1.38E-08	Pr-144	7.94E-07	8.05E-07
In^{+3}	1.82E-06	1.84E-06	Y^{+3}	8.99E-06	9.11E-06	Am-242	1.35E-08	1.37E-08	Nd-144	2.04E-15	2.06E-15
I^{-}	3.32E-06	3.37E-06	Zn^{+2}	5.00E-04	5.10E-04	Am-243	1.92E-08	1.94E-08	Pm-146	6.45E-08	6.54E-08
Fe^{+3}	7.79E-03	7.82E-03	Zr^{+4}	2.63E-04	2.65E-04	Cm-242	3.41E-08	3.45E-08	Pm-147	2.16E-04	2.19E-04
La^{+3}	1.21E-05	1.22E-05	O-2			Cm-243	3.60E-08	3.65E-08	Sm-146	3.49E-13	3.54E-13
Pb^{+2}	3.10E-04	3.12E-04	H2O	4.35E+01	4.32E+01	Cm-244	1.44E-06	1.46E-06	Sm-147	9.33E-12	9.46E-12
Li^{+}	4.53E-04	4.60E-04				Cm-245	3.78E-10	3.83E-10	Sm-148	4.79E-17	4.86E-17
Mg^{+2}	2.49E-02	2.53E-02		g/liter	g/liter	Cm-246	2.49E-11	2.53E-11	Sm-149	4.26E-18	4.32E-18
Mn^{+4}	2.59E-02	2.67E-02	TOC	4.9	5.0				Sm-151	4.25E-04	4.31E-04
Hg^{+2}	9.03E-03	7.20E-03	UDS	4.2	4.1	H-3	1.94E-05	1.97E-05	Eu-150	1.82E-11	1.85E-11
Mo^{+6}	3.11E-04	3.15E-04				Be-10	3.80E-12	3.85E-12	Eu-152	3.19E-06	3.23E-06
Nd^{+3}	3.89E-05	3.94E-05		Ci/liter	Ci/liter	C-14	1.52E-10	1.54E-10	Eu-154	2.09E-04	2.12E-04
Np^{+4}	2.22E-05	2.25E-05		(Jan, 2003)	(Jan, 2003)	Se-79	5.53E-07	5.61E-07	Eu-155	1.92E-04	1.95E-04
Ni^{+2}	7.34E-04	7.62E-04	Ra-226	1.04E-11	1.05E-11	Rb-87	3.71E-11	3.76E-11	Gd-152	1.80E-18	1.83E-18
Nb^{+5}	1.19E-04	1.20E-04	Ac-227	4.89E-11	4.95E-11	Sr-90	5.01E-02	5.08E-02	Ho-166m	5.83E-11	5.91E-11
NO_3^{-}	7.35E+00	7.45E+00	Th-230	1.04E-09	1.06E-09	Y-90	5.01E-02	5.08E-02	Co-60	4.13E-05	4.19E-05
Pd^{+4}	1.40E-04	1.42E-04	Th-231	2.66E-08	2.70E-08	Zr-93	2.81E-06	2.85E-06	Ni-63	4.37E-05	4.43E-05

2.5 SBW Treatment Facility Feed Compositions

Compositions for both SBW and NGLW wastes have been presented in Sections 2.1-2.4. Table 23 shows a summary of the volumes of waste to be treated and tables containing compositions for these wastes.

Table 23. Summary of waste to be processed.

	CsIX		**Other Processes**
	gal liquid	kg solid	gal liquid plus solids
WM-187	270,963	105,000	284,920
WM-188	281,670	5,000	281,670
WM-189	279,800	10,000	279,800
NGLW	72,180	1,130	72,180
Total	**904,613**	**121,130**	**918,570**
	Composition		Composition
WM-187	Table 2, "Liquid only"		Table 2. "With solids"
	Table 4 (solids)		
WM-188	Table 7, "No solids"		Table 6
	Table 8 (solids)		
WM-189	Table 10, "No solids"		Table 9
	Table 8 (solids)		
NGLW	Table 22		Table 22

Volumes in Table 23 do not show any steam jet dilution to blend the wastes or transfer wastes to the treatment facility. Water to transfer heels to treatment is also not shown. Existing steam jets typically add about 5% to the volume of tank waste in transfers to the NWCF. Possible blend scenarios and blend compositions are discussed in Section 3.4. Liquid volumes shown in Table 23 for the CsIX process for Tanks WM-188 and WM-189 neglect the small volume of solids in these tanks.

Concentrations shown in Tables 2, 3, 6, 7, 9 and 10 have been adjusted to ensure charge balance and consistency between radionuclide activities and chemical concentrations. Nitrate concentrations were adjusted to obtain charge balance.

To check for consistency between radionuclide activities and chemical concentrations, activities of radionuclides were converted to molar concentrations and compared to concentrations measured or estimated for the respective chemical species. If the sum of the concentrations of all isotopes of an element, converted from activities, was greater than the chemical concentration for that element, the chemical concentration was replaced by that sum.[d] For example, if the concentration of Americium (as calculated by converting ^{241}Am, ^{242m}Am, ^{242}Am, and ^{243}Am concentrations in curies per liter to moles per liter and summing) was greater than the molar concentration of Am reported as a chemical species, then the sum of the isotopes was used as the chemical concentration. If the chemical concentration was greater than the sum of the radionuclide concentrations, and no non-radioactive isotopes occur for that element, the radionuclide concentrations were increased to be consistent with the chemical concentration. Adjustments were made for the elements U, Np, Am, Pu, Tc, and In.

[d] In most cases, the chemical concentration is greater than that of the same species calculated from isotopic concentrations because of nonradioactive isotopes.

Chemical species present in concentrations less than 10^{-9} mol/liter and isotopes having concentrations less than 10^{-15} mol/liter were not included in Table 18.[e] For the generated waste, concentrations of species for which no analytical data or other estimates were available were assumed equal to the average concentration in the SBW tanks for that species.

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[e] If the activity was greater than 10^{-8} Ci/liter, the radionuclide was retained even if its molar concentration was less than 10^{-15}.

3. SUPPLEMENTAL FEED CHARACTERIZATION INFORMATION

This section provides more detail and discussion regarding the quantity of solids in the Tank Farm, the composition of tank solids, uncertainties in the waste compositions shown in this report, possible tank blending scenarios and resulting tank compositions, waste physical properties, and organics in the waste.

3.1 Tank Solids Quantity

Light Duty Utility Arm (LDUA) video evidence of the height of tank sludge layers, along with measurement of sludge samples from these tanks, provided good estimates of solids quantities for three tanks. Tank WM-188 was sampled using the LDUA in 1998 (Patterson 1999); and WM-182 and WM-183 in 2000 (Poloski 2000a). Based on the videos, the sludge layers in Tanks WM-188, WM-182, and WM-183 were estimated to be 0.25-inch, 4 inches, and 8 inches respectively. Using the history of each tank as a guide, and measurements from WM-183 samples that showed the sludge was approximately 25 vol % solids and that the solids had a particle density of 2 kg/liter, Poloski estimated sludge volumes (Poloski 2000a) and Tyson estimated the corresponding mass of solids in each tank in the Tank Farm (Tyson 2002). These sludge volume and mass estimates, shown in Table 24, have been widely used since they were developed for SBW treatment studies, (Barnes 2002) the SBW Waste Incidental to Reprocessing (WIR) evaluation (Tyson 2002), and the basis for the radiological source term for Tank Farm safety analyses (Swenson 2002).

Table 24. Estimated solids quantities based on LDUA samples and videos.

Tank	Sludge Height (in.)	Sludge on Walls (equiv. in.)	Total Sludge (equiv. in.)	Total Solids (kg)
WM-180 (like WM-182)	4.00	0.50	4.5	10,452
WM-181 (like WM-182)	4.00	0.50	4.5	10,452
WM-182	4.00	0.50	4.5	10,452
WM-183	8.00	0.50	8.5	19,743
WM-184 (like WM-182)	4.00	0.50	4.5	10,452
WM-185 (like WM-182)	4.00	0.50	4.5	10,452
WM-186 (like WM-182)	4.00	0.50	4.5	10,452
WM-187 (like WM-188)	0.25	0.25	0.5	1,161
WM-188	0.25	0.25	0.5	1,161
WM-189 (like WM-188)	0.25	0.25	0.5	1,161
Total	**32.75**	**4.25**	**37.0**	**85,941**

Since the estimates listed in Table 24 were made, the following tank farm changes have occurred: (1) wastes from Tanks WM-181, WM-184, WM-186, and WM-185 have been evaporated to heel level and the concentrate added to Tanks WM-188 and WM-189, (2) Tanks WM-189, WM-188, WM-181, and WM-187 have been sampled, and (3) solids in Tanks WM-181, WM-182, WM-183, WM-184, WM-185, and WM-186 have been flushed to WM-187. Because of these changes, solids remain only in Tanks WM-187, WM-180, WM-188, and WM-189. The solids in WM-180 are scheduled to be flushed to WM-187 later in 2004.

During evaporation of waste from Tank WM-186, as the waste was lowered to about the 15,000 gallon level, severe plugging problems were experienced in ETS instrument probes and some other lines (Swenson 2001). Evaporation of waste from Tanks WM-181 and WM-185, in addition to WM-186, was stopped when high undissolved solids caused plugging in instrument probes.[f] The heel level of each of these three tanks when processing by evaporation was stopped was between 13,000 and 23,000 gallons. The solids seen in the evaporator probes suggest that there may be more solids in these tanks than shown in Table 24, which, for tanks WM-181, WM-185, WM-186 and others, was based on a heel of only 5,000 gallons in each tank.

In March 2002, a sample from near the bottom of Tank WM-189 was taken using an existing steam jet located approximately 2-inches off the tank bottom. The 165 ml sample was allowed to settle for 24 hours, at which time a sludge layer of approximately 22 ml was seen (Batcheller 2003). In contrast, undissolved solids from a sample taken by steam jet, ~3-inches off the bottom, from Tank WM-180 were measured to be only 0.23 g/liter. While a direct comparison of data from these two tank samples is difficult, it appears that the WM-189 sample had considerably more solids than the WM-180 sample.

In light of the above indications that there could be more solids than originally estimated, the following estimates are proposed for the quantity of solids that will be present in the tanks at the commencement of SBW treatment, and have been used in composition estimates earlier in this report.

Table 25. Updated solids estimate.

	Expected	**Maximum**
WM-187	105,000 kg	135,000 kg
WM-188	5,000 kg	10,000 kg
WM-189	10,000 kg	20,000 kg
Total	**120,000 kg**	**165,000 kg**

The basis for the above estimates is as follows:

- **WM-187**: Summing the volume of heels flushed to WM-187 and assuming an average 16 vol % solids[g] in the sludge and a solids density of 2 kg/liter results in as estimate of 100,000 kg, exclusive of solids from WM-180. Tank WM-180 has not yet been emptied and so the heel level is not known. For WM-180, assuming 3-inches of sludge with an average solids content of 16-vol %[g] and a solids density of 2 g/cm^3 is equivalent to about 5,000 kg of solids. Thus the total solids estimated to be in Tank WM-187 is 105,000 kg. This expected amount estimate is consistent with the actual tank level on April 3, 2004 (58,000 gallons) and a solids content of about 18 vol %. The maximum amount was estimated by adding 30% (30,000) to the 100,000 kg estimate. The maximum estimate is consistent with the maximum solids content seen in any heel (25 vol %, WM-183), taking into account that not all solids from WM-181 and none from WM-180 had been flushed to WM-187 as of April 3, 2004.

- **WM-188 and WM-189**: When Tank WM-188 was at heel level, LDUA videos showed very few (~1/4 inch) solids (Patterson 1999). WM-188 has since been filled with ETS concentrate. A sample taken from WM-189, which was filled with much the same evaporator concentrate, showed

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[f] Personal communication with Dan Griffith, October 23, 2002.

[g] A solids content of 16 vol % is based on the solids content of WM-183 heel in early 1997 and also the average of WM-183 LDUA sludge sample solids content (25 %) and WM-189 sludge solids content (~7%).

significantly more solids than similar samples from WM-180 and WM-188. Consistent with this observation is the fact that high solids waste streams (NWCF flushes and off-gas scrub) have been added to WM-189 and not to WM-188. Thus, Tank WM-189 should have more solids than WM-180 or WM-188. For lack of additional data, the amount of solids WM-188 was assumed to be equal to that estimated for WM-180 (5,000 kg) and the amount in WM-189 twice the amount in WM-180. The estimated expected amount of settled solids in WM-189 is consistent with the measured solids content of a sample from that tank and a heel volume of about 20,000 gallons.

3.2 Tank Solids Composition

After 2004, SBW will be contained in three INTEC Tank Farm tanks. The majority of the solids (~90%) will be contained in one tank, WM-187. It has not been possible to obtain a well-mixed, representative sample of solids from this tank. However, eleven samples from eight tanks have been taken since 1999 that have contained solids. This section presents a compilation, comparison and review of the solids analytical data. It also contains the basis for determining the average composition of solids in Tank WM-187.

Mike Swenson compiled older data for tank solids, mostly from the mid-1980's (Swenson 1992). In general, this older data is similar to more recent analyses, and indicate that the primary chemical species present in the solids are zirconium and phosphate, with smaller amounts of aluminum, iron, silicon, sodium, potassium, boron, nickel and tin. Other information in Swenson's report suggests the solids could contain significant levels of fluorides and noble metals.

Direct sampling of tank heels using the LDUA was performed in three tanks in 1999. Table 26 shows the results of analyses of these samples.

Table 26. Analyses of solids samples from Tanks WM-182, WM-183, and WM-188.

	WM-182 mg/kg	WM-183 mg/kg	WM-188 mg/kg		WM-182 mg/kg	WM-183 mg/kg	WM-188 mg/kg
Al^{+3}	21,880	24,911	35,406	Sr^{+2}	<9	11	
Sb^{+5}	<14	32	<34	SO_4^{-2}	33,240	13,647	
As^{+5}	281	56	351	S^{+6}	8,743	2,849	
Ba^{+2}	127	24	12,542	Tc^{+7}		0	
Be^{+2}	<1	<0.9	0.2	Tl^{+3}	<17	<14	<783
B^{+3}	150	182	<482	Sn^{+4}	4,072	1,466	
Cd^{+2}	325	142	1,189	Ti^{+4}	650	711	
Ca^{+2}	1,765	1,868	5,630	U^{+4}	<46	0.193	
Ce^{+4}	<21	20		V^{+5}	13	11	6
Cs^{+}	42	9	<128	Zn^{+2}	179	148	126
Cl^{-}	2,015	1,308		Zr^{+4}	101,470	34,867	70,600
Cr^{+3}	552	949	1,341	Total	437,827	486,039	165,675
Co^{+2}	<9	9	9	TOC			<1215
Cu^{+2}	298	166					
F^{-}	14,800	4,373			WM-182	WM-183	WM-188
Gd^{+3}	53	170			mCi/g	mCi/g	mCi/g
Fe^{+3}	4,476	17,967	5,769		(Jan, 2000)	(Jan, 2000)	(March, 1999)
Pb^{+2}	369	274	647	Am-241	8.46E-04	2.45E-04	2.11E-04
Li^{+}	6	4		Sb-125	5.77E-02	2.90E-03	1.12E-02
Mg^{+2}	410	434		Cs-134	6.64E-03	5.89E-04	7.97E-03
Mn^{+4}	565	740	758	Cs-137	4.24E-01[a]	8.68E-01	2.44E+00
Hg^{+2}	310	324	1,566	Co-60	2.14E-04		6.30E-04
Mo^{+6}	2,495	694	2,770	Cm-244	2.84E-06		
Ni^{+2}	309	417	427	Eu-154	1.48E-03	7.56E-04	5.43E-04
Nb^{+5}	1,279	623	5,370	I-129	<2.22E-07	<9.03E-08	<1.53E-03
NO_3^{-}	70,720	174,955		Np-237	1.68E-06	1.76E-06	2.85E-06
Pd^{+4}	5,766	1,444		Pu-238	1.93E-02	4.00E-03	7.56E-03
PO_4^{-3}	68,410	125,612		Pu-239	1.47E-03	1.25E-03	4.30E-04
P^{+5}	9,586	4,607	17,700	Sr-90	2.29E-01	1.82E-01	5.46E+00
K^{+}	7,050	10,900		Tc-99	2.63E-03	3.29E-05	4.49E-03
Ru^{+3}	829	2,126	<313	H-3	1.15E-05		
Se^{+4}	91	<13	<1,720	U-234	<2.40E-06	3.30E-06	<2.10E-05
Si^{+4}	43,920	35,344		U-235	2.61E-07	9.29E-08	1.97E-07
Ag^{+}	65	220	9	U-236	3.05E-07	<3.40E-08	<2.20E-07
Na^{+}	30,400	21,400		U-238	3.83E-08	6.91E-08	1.18E-07

[a] Concentration corrected based on reissued lab report

Table 27 shows results of analyses of samples taken of Tank Farm waste transferred to the NWCF blend and hold cell for sampling. Tank WM-180 was sampled in June 2000; the tank was full of waste at the time of sampling. The solids were obtained from the waste sample by allowing two weeks for settling, drawing off liquid, and centrifuging the remaining sample. The solids were not washed but Jerry Christian states that approximately 4% of the weight of the dried solids was due to dissolved solids in interstitial liquid that crystallized during drying (Christian 2000). The WM-180 analytical results shown in Table 27 are as reported by Garn (2001).

Tanks WM-181, WM-186 and WM-188 were sampled in 2003. Tanks WM-181 and WM-186 were at heel level when sampled, while WM-188 was about three-quarters full of liquid. Solids from each of these tanks were washed with water prior to analysis. Results of analyses of WM-180, WM-181, and WM-188 samples are shown in Table 27. Solids from WM-186 were analyzed by different methods, (see Section 3.4 of Rev. 3 of this report) and results are shown in Table 28.

Table 27. Analysis data for tank solids samples obtained through NWCF.

	WM-180	WM-181	WM-188		WM-180	WM-181	WM-188
	mg/kg	mg/kg	mg/kg		mg/kg	mg/kg	mg/kg
Al^{+3}	59,619	5,870	14,568	Na^{+}	81,200	2,926	35,291
Sb^{+5}	41	19	<9	Sr^{+2}	23		14
As^{+5}	<10	36	<40	SO_4^{-2}	9,220	3,974	10,787
Ba^{+2}	34	10	29	S^{+6}	5,199		3,711
Be^{+2}	<2	0.23	<2	Tc^{+7}	0		
B^{+3}	<520	49	413	Tl^{+3}	<1,360	<4	50
Cd^{+2}	183	61	216	Sn^{+4}	2,120	4,117	2,178
Ca^{+2}	4,427	449	2,396	Ti^{+4}	959		477
Ce^{+4}	44		<30	U^{+4}	353		330
Cs^{+}	524		<25	V^{+5}	<13	<5	12
Cl^{-}	909	1,110		Zn^{+2}	200	27	73
Cr^{+3}	692	241	621	Zr^{+4}	27,971	37,930	32,209
Co^{+2}	<15	<1	7	Total	815,414	272,464	258,274
Cu^{+2}	139	41	55	Radionuclides			
F^{-}	93	2,165			mCi/g	mCi/g	mCi/g
Gd^{+3}	84		25		(Oct 2000)	(2003)	(2003)
Fe^{+3}	20,200	3,985	4,385	Am-241	3.20E-04	1.49E-04	5.31E-04
Pb^{+2}	541	47	175	Sb-125	3.37E-03	2.45E-03	1.17E-02
Li^{+}	<160		<17	Cs-134	2.62E-04	3.37E-04	1.70E-03
Mg^{+2}	1,402	235	460	Cs-137	2.63E-01	2.43E-01	2.62E+00
Mn^{+4}	1,618	116	579	Co-60	3.59E-05	7.18E-05	7.75E-04
Hg^{+2}	<8,930	25		Cm-244			1.70E-05
Mo^{+6}	357	283	207	Eu-154	4.32E-04	2.07E-04	2.12E-03
Ni^{+2}	282	57	355	I-129			
Nb^{+5}	<1,040		1,888	Np-237	3.41E-06	6.23E-07	6.41E-06
NO_3^{-}	455,000	645		Pu-238	8.76E-02	1.43E-02	2.45E-02
Pd^{+4}	<760		345	Pu-239	1.31E-02	1.42E-03	3.36E-03
PO_4^{-3}	37,000	197,980	25,428	Sr-90	6.24E-02		5.51E-02
P^{+5}	54,360		54,901	Tc-99	2.42E-05		2.23E-03
K^{+}	15,200	8,761	12,309	H-3			
Ru^{+3}	360		<803	U-234	4.49E-06	3.07E-06	1.18E-05
Se^{+4}	<1,280		<43	U-235	9.24E-08	2.15E-07	8.89E-07
Si^{+4}	20,920		52,601	U-236	1.74E-07	1.86E-07	
Ag^{+}	50	1,299	190	U-238	3.95E-08	2.26E-09	2.09E-07

Table 28. Analysis data for tank solids sample from WM-186.

SEM elemental analysis

	Min Wt %	Ave Wt %	Max Wt %
Al	5.84	6.26	6.76
Fe	0.94	1.47	2.01
K	1.07	1.14	1.22
Na	0.36	0.64	1.01
O	49.62	50.2	50.63
P	10.74	11.01	11.19
Si	11.63	11.85	12.01
Zr	16.07	17.4	18.3
Total	**96.27**	**99.97**	**103.13**

X-ray fluorescence analysis, water washed

	Wt %
Zr	74.71
K	6.55
Fe	5.80
Ca	3.70
Sn	2.08
Mn	1.93
Zn	1.26
Nb	1.20
Ti	0.92
Cr	0.84
Ni	0.40
Hg	0.32
Br	0.22
Au	0.09
Total	**100.02**

Tank WM-187 has been sampled several times between July 2003 and February 2004. The tank heel at the time of the first sample contained only solids from Tanks WM-182 and WM-183, while heels from WM-184, WM-185, and WM-186 had been added before the second sample was taken. Prior to the final sample, taken in February 2004, a portion of the heel from WM-181 had been transferred to WM-187 in an attempt to include these solids in the tank sample. Then, five separate transfers of about 6,000 gallons each were made back and forth between WM-187 and the sampling tanks, NCC-102 and NCC-103. This was done in an attempt to better mix the solids in Tank WM-187. Following these transfers, a transfer of about 1100 gallons was made from WM-187 and sampled. However, the particle size distribution of solids from the final sample shows a smaller average particle size that any of the other tanks or samples. Hence, the final sample may contain a disproportionately high fraction of smaller, more mobile particles than contained in the total solids in the tank. Results of analyses of the second sample will be reported by Janikowski later this year, while results for the first and third sample are shown in Table 29.

Table 29. Analysis data for tank solids samples from WM-187.

	WM-187 Sample 1	**WM-187** Sample 3		**WM-187** Sample 1	**WM-187** Sample 3
	mg/kg	mg/kg		mg/kg	mg/kg
Al^{+3}	10,616	11,059	Th^{+4}	60	16
Sb^{+5}	<64	40	Sn^{+4}	4,208	4,363
As^{+5}	98	68	Ti^{+4}	1,429	
Ba^{+2}	12	98	W^{+4}	230	402
Be^{+2}	<2	<1	U^{+4}	<236	<222
B^{+3}	130	161	V^{+5}	<28	<14
Cd^{+2}	11	6	Y^{+3}	<33	<31
Ca^{+2}	570	536	Zn^{+2}	196	148
Ce^{+4}	<30	73	Zr^{+4}	66,464	38,644
Cs^{+}	68	81			
Cr^{+3}	307	444	Cl^{-}	14,394	3,051
Co^{+2}	<10	<9	NO_3^{-}	56,514	1,034
Cu^{+2}	69	84	PO_4^{-3}	221,788	231,089
Gd^{+3}	8	5	SO_4^{-2}	18,429	4,386
Hf^{+4}	166	66	F^{-}	2,584	30
Fe^{+3}	20,119	6,100			
Pb^{+2}	<37	76		**Ci/g**	**Ci/g**
Li^{+}	<14	<13	Am-241	3.0E-07	2.3E-07
Mg^{+2}	247	388	Sb-125	6.7E-06	9.1E-07
Mn^{+4}	62	71	Cs-134	5.1E-07	1.3E-07
Hg^{+2}	329	60	Cs-137	1.2E-03	2.8E-04
Mo^{+6}	923	310	Co-60	6.9E-08	2.7E-08
Ni^{+2}	43	52	Cm-242	1.4E-10	
Nb^{+5}	1,641	1,235	Cm-244	6.0E-10	8.3E-10
P^{+5}	4,587	79,682	Eu-154	2.8E-07	1.6E-07
K^{+}	3,475	3,360	Np-237	1.7E-09	1.7E-09
Se^{+4}	<49	<42	Pu-238	9.9E-06	2.0E-05
Si^{+4}	104,669	149,374	Pu-239	2.3E-06	3.4E-06
Ag^{+}	91	3,686	Sr-90	1.7E-05	1.4E-05
Na^{+}	637	2,924	Tc-99	3.5E-06	2.2E-07
Sr^{+2}	7	5	H-3	5.8E-08	2.8E-10
S^{+6}	2,728	1,747	U-234	3.5E-09	1.7E-09
Te^{+4}	<61		U-235	5.3E-10	
Tl^{+3}	<49	<36	U-238	1.3E-10	

To compare the solids composition data from the different tanks, the following adjustments or corrections were made:

- Contributions due to interstitial liquid were subtracted from the raw analytical results for Tanks WM-182 and WM-183. From mass and volume measurements made during drying the WM-183 LDUA sample, it was determined interstitial liquid accounted for 27.6 wt % of the dried solids sample. Analytical data for WM-183 liquid samples taken at the same time as the sludge sample was used to make this adjustment. The same fraction of interstitial liquid was assumed for the WM-182 sample, since no drying measurements were available. For a few species such as nitrate and ^{155}Eu, this subtraction gave negative concentrations, which were then changed to zero. A correction for interstitial liquid was also made to the composition WM-180 solids.

- Weight fractions of oxide for each sample were calculated by charge balance.
- The amount of hydrated water was estimated for samples for which it was not measured. The amount of hydrated water was estimated by assuming a 3 to 1 molar ratio of hydrates to phosphates and sulfates and a ratio of 1.16 moles hydrate per mole of nitrate.
- Analyses were not performed for some species for every sample. For these cases, the average concentration from tank samples for which these analyses were made was assumed.
- All phosphorus was assumed present as phosphate and all sulfur as sulfate. The higher concentration of phosphorus or phosphate was assumed for the phosphate concentration and the higher concentration of sulfur or sulfate was assumed for sulfate.

Table 30 shows the adjusted solids compositions. Values shown in italics correspond to undetected species, and the value shown for these species is the detection limit. Solids from Tank WM-186 were analyzed by different methods that the other samples and concentrations shown are normalized, whereas concentrations for the other tanks are not.

Both similarities and difference can be seen in solids concentrations shown in Table 30. The predominant anions in all samples but one are phosphate and oxide, while the predominant cations in all samples are silicon, zirconium and aluminum. Sodium, potassium, sulfate, iron, chloride, fluoride and tin occur in lesser but significant concentrations in most samples. Solids in Tank WM-180 appear to be the least similar to those in other tanks, being very high in nitrate and high in sodium relative to the other samples. Also, the sum of the concentrations for Tank WM-180 is slightly greater than unity, in contrast to all other tanks (except the normalized WM-186). The two samples from WM-187 show high concentrations of silicon and low concentrations of sodium, potassium and calcium relative to the other tank samples, even though these solids came from the other tanks.

Table 31 compares concentrations of major radionuclides, and shows large variations in concentrations between samples from the different tanks. No radionuclide analyses were performed for the sample from Tank WM-186. Concentrations shown in Table 31 for samples taken prior to 2003 were adjusted by decaying activities to January 2003.

Table 30. Comparison of tank solids compositions.

	WM-180	WM-181	WM-182	WM-183	WM-186	WM-187-1	WM-187-3	WM-188-1	WM-188-2
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Al+3	58,460	5,870	12,425	10,489	52,507	10,616	11,059	35,406	14,568
Sb+5	40	19	*17*	41	41	*64*	40	*34*	*29*
As+5	*7*	36	335	73	148	98	68	351	*40*
Ba+2	34	10	145	18	1,661	12	98	12,542	29
Be+2	*2*	*2*	*1*	*1*	1	*2*	*1*	*2*	*2*
B+3	*511*	49	100	51	261	130	161	*482*	413
Cd+2	177	61	282	32	276	11	6	1,189	216
Ca+2	4,303	449	1,214	449	7,866	570	536	5,630	2,396
Ce+4	43	35	*19*	15	35	*30*	73	35	*30*
Cs+	524	126	45	0	133	68	81	*128*	25
Cl-	909	1,110	1,891	1,168	3,451	14,394	3,051	3,754	3,754
Cr+3	681	241	486	398	1,786	307	444	1,341	621
Co+2	*15*	*1*	*10*	2	8	*10*	*9*	9	7
Cu+2	136	41	331	77	119	69	84	113	55
F-	33	2,165	16,603	4,426	5,916	2,584	30	4,307	0
Gd+3	81	25	24	8	38	8	5	25	25
Fe+3	20,120	3,985	4,251	20,123	12,330	20,119	6,100	5,769	4,385
Pb+2	524	47	314	76	257	*37*	76	647	175
Li+	*160*	35	5	2	34	*14*	*13*	35	*17*
Mg+2	1,383	235	434	195	462	247	388	477	460
Mn+4	1,568	116	271	106	4,103	62	71	758	579
Hg+2	*8,904*	25	73	0	680	329	60	1,566	0
Mo+6	356	283	2,958	816	1,267	923	310	2,770	207
Ni+2	275	57	281	129	850	43	52	427	355
Nb+5	*1,004*	0	1,526	818	2,551	1,641	1,235	5,370	1,888
NO3-	434,300	645	0	0	0	56,514	1,034	0	0
Pd+4	*760*	2,476	6,888	1,913	2,045	2,476	2,476	2,476	345
PO4-3	166,590	197,980	81,686	166,567	283,160	221,788	231,089	60,814	168,335
K+	14,710	8,003	4,924	9,243	9,562	3,475	3,360	8,003	12,309
Ru+3	359	1,051	980	2,798	1,110	1,051	1,051	*313*	803
Se+4	*1,279*	*52*	109	*16*	530	*49*	*42*	*1,720*	*43*
Si+4	20,920	71,114	52,416	46,707	99,395	104,669	149,374	71,114	52,601
Ag+	49	1,299	77	291	865	91	3,686	9	190
Na+	78,160	2,926	18,885	3,945	5,368	637	2,924	20,521	35,291
Sr+2	22	9	*5*	0	10	7	5	9	14
SO4-2	15,140	3,974	36,996	13,903	17,530	18,429	4,386	14,802	10,787
Tl+3	*1,359*	*4*	*19*	*16*	267	*49*	*36*	*783*	*50*
Sn+4	2,120	4,117	4,863	1,942	4,422	4,208	4,363	0	2,178
Ti+4	959	916	774	939	1,956	1,429	916	916	477
U+4	348	*206*	*46*	206	189	*236*	*222*	206	*330*
V+5	*10*	5	0	11	38	*28*	*14*	6	*12*
Zn+2	196	27	177	57	2,679	196	148	126	73
Zr+4	27,970	37,930	121,001	46,051	145,947	66,464	38,644	70,600	32,209
O-2	32,694	55,747	96,591	48,073	157,146	96,258	143,008	140,932	60,942
Hydrates	250,001	115,119	67,300	102,611	171,001	155,669	134,324	42,935	101,864
Total	**1,148,196**	**518,623**	**537,778**	**484,801**	**1,000,000**	**786,112**	**745,154**	**519,452**	**509,130**

Table 31. Comparison of solids radiological composition.

	Cs-137	Sr-90	U-235	U-238	Pu-238	Pu-239
	Ci/kg	Ci/kg	Ci/kg	Ci/kg	Ci/kg	Ci/kg
WM-180	0.21	4.8E-02	8.9E-08	3.8E-08	8.1E-02	1.3E-02
WM-181	0.24	6.0E-03	2.2E-07	2.3E-09	1.4E-02	1.4E-03
WM-182	0.34	8.5E-03	2.3E-07	2.2E-08	1.4E-02	1.2E-03
WM-183	0.72	6.8E-03	1.5E-07	3.6E-08	2.9E-03	1.0E-03
WM-187-1	1.18	1.7E-02	5.3E-07	1.3E-07	9.9E-03	2.3E-03
WM-187-2	0.28	1.4E-02	5.3E-07	1.3E-07	2.0E-02	3.4E-03
WM-188-1	1.93	2.0E-01	1.7E-07	6.8E-08	5.6E-03	3.6E-04
WM-188-2	0.26	5.5E-02	8.9E-08	2.1E-08	2.4E-03	3.4E-04
Minimum	0.21	0.006	8.9E-08	2.3E-09	2.4E-03	3.4E-04
Maximum	1.93	0.20	5.3E-07	1.3E-07	8.1E-02	1.3E-02
Average	0.64	0.04	2.5E-07	5.5E-08	1.9E-02	2.9E-03
Median	0.31	0.02	1.9E-07	3.7E-08	1.2E-02	1.3E-03
Standard Deviation	0.62	0.07	1.8E-07	4.8E-08	2.6E-02	4.2E-03
(Max-Ave)/SD	2.1	2.4	1.6	1.5	2.4	2.4
(Ave-Min)/SD	0.7	0.6	0.9	1.1	0.6	0.6
SD/Average	1.0	1.5	0.7	0.9	1.4	1.5

Revision 3 of this report (Barnes 2003) included an estimated composition of solids that would be in Tank WM-187. Table 32 compares the results of the FY 2004 WM-187 solids sample analysis to the predicted composition for major chemical and radionuclide species. As seen in the table, the concentrations of numerous species fall outside the expected range. This comparison suggests that tank samples may not be representative of a tank's total solids. As discussed in Section 3.3, it may also suggest that transfers of solids between tanks can result in compositional changes.

Because of the differences between the recent WM-187 sample analyses results and the composition expected, the present assumed composition of Tank WM-187 solids (Table 4) is not identical to the recent sample analyses. If the concentration of a chemical species in the recent analysis was outside the range of the concentrations of tanks that were flushed to WM-187, then it was replaced by the average concentration of those tanks plus both WM-187 sample analyses. Concentrations shown in Table 4 for Al, Cd, F, Gd, Pb, Mn, Hg, Ni, and Ag are averages. Concentrations for Ca, Fe, PO_4, K, SO_4, Zr, and H_2O were normalized to bring the sum of all species to 100%. Radionculide concentrations less than 80% or greater than 150% of the average were also replaced by the average.

Table 32. Comparison of recent WM-187 analyses to that predicted from previous data.

	FY-2004	Rev. 3 SBW Feed Report			
	Analysis	Low	Expected	High	Comparison of FY-2004
	Wt %	Wt %	Wt %	Wt %	Analysis to Rev. 3 Range
Al^{+3}	1.11	1.2	1.38	2.2	92% of low
Ca^{+2}	0.05	0.093	0.12	0.23	58% of low
Cl^{-}	0.31	0.092	0.21	0.31	100% of high
Fe^{+3}	0.61	0.92	1.1	1.8	66% of low
PO_4^{-3}	23.1	20	25.4	36	close to expected
K^{+}	0.34	1.1	1.27	1.7	31% of low
Si^{+4}	14.9	5.4	6.86	8	187% of high
Na^{+}	0.29	0.96	1.4	2.7	30% of low
SO_4^{-2}	0.44	1.2	2.19	2.8	37% of low
Sn^{+4}	0.44	0.44	0.587	0.67	100% of low
Zr^{+4}	3.86	5.9	9.15	10	65% of low
O^{-2}	14.3	3.4	6.66	4.8	300% of high
Hydrates	13.4	34	41	48	40% of low
Co-60	2.68E-05	3.20E-05	3.77E-05	5.90E-05	84% of low
Sr-90	1.42E-02	8.90E-03	1.00E-02	2.40E-02	within expected range
Tc-99	2.19E-04	7.30E-05	8.99E-05	1.40E-04	157% of high
Cs-137	2.77E-01	2.90E-01	3.55E-01	4.70E-01	96% of low
U-235	5.31E-07	8.80E-08	1.99E-07	3.00E-07	177% of high
U-238	1.28E-07	3.20E-09	1.56E-08	3.30E-08	387% of high
Np-237	1.73E-06	8.50E-07	1.15E-06	1.60E-06	108% of high
Pu-238	1.98E-02	7.10E-03	1.15E-02	2.80E-02	within expected range
Pu-239	3.37E-03	1.22E-03	8.20E-04	4.00E-03	within expected range
Am-241	2.33E-04	1.40E-04	2.98E-04	3.70E-04	within expected range

3.3 Feed Composition Uncertainties

The SBW treatment facility feed could vary from compositions presented in this report for several reasons, including: (1) analytical uncertainties in tank sample analyses, (2) species present in waste for which no analysis was done or which were not detected (2) actual NGLW that differs in rate or composition from that projected, (3) actual amounts of tank solids that differ from estimates, (4) nonrepresentativeness of tank solids samples, (5) processes occurring over time that could change the amount or composition of solids, and (6) potential changes in the tank farm management that could affect volumes and compositions of tank waste.

For recent analyses of Tank WM-189 and WM-188 samples, Batcheller (2003) and Johnson (2003a; 2003b) estimated analytical uncertainties to be 10% for most cations and 20 to 25% for Hg, Sb, Ce, Si, Ag, U, and Te. Anion concentrations were determined by ion chromatography, a different method than that used for cation concentrations, and the uncertainty for anion species is estimated to be larger than for other species, but has not been quantified.

Batcheller (2003) and Johnson (2003a; 2003b) have also reported uncertainties in measured radionuclide concentrations. While the analytical uncertainties for many radionuclides are less than 20%, the uncertainty in uranium and plutonium isotopes ranges from 13 to 100%. Typically, analyses of a tank waste sample are performed for only 15 to 25 isotopes. Concentrations of others are estimates, based on the assumption that the radionuclide concentrations in present waste are proportional to all the nuclear fuel processed at the ICPP over the lifetime of the plant. The uncertainty for these estimates is expected to be ±100%, but could be larger.

SBW contains a very large number of species due to its source. Typically, samples are analyzed for about 50 chemical species. Concentrations reported for others are estimates and could contain large errors. When analyses do not detect an element in a sample, the element is assumed present at a concentration corresponding to the detection limit, and these concentrations could have large errors. However, both for species not detected and species estimated, because their concentrations in the SBW are very small, these uncertainties are expected to have a negligible effect on most treatment processes.

Approximately 6 to 8% of the total liquid feed will be NGLW. Although the uncertainty in generated waste composition is high, the effect of this uncertainty on the SBW treatment facility feeds will be low for several reasons. The NGLW compositional data that are available generally show that the composition of NGLW, when concentrated, is similar to SBW composition. Thus, deviations from historical analyses will likely still fall within the range of SBW compositions for most species. And since NGLW itself is a blend of several dozen different waste streams, compositional variations in a few of the streams will have only a small effect on the composition of the final concentrated waste. Finally, the NGLW could be blended with SBW to further reduce the effect uncertainties and fluctuations in NGLW composition would have on the treatment process.

The uncertainty in the total quantity of tank solids is discussed in Section 3.1. The total volume of waste (liquid plus solids) is known to a high degree of accuracy based on tank volume measurements. For treatment processes that co-process solids and liquids, if the volume of solids is greater than expected, the volume of liquid will be less, and the effect on the process will be small. For the CsIX treatment process, or any other process that treats the solids separately, some of the equipment may be sized based on solids throughput, and thus will be affected by the total tank solids quantity. However, for any treatment process, the effect of more solids on individual equipment should be evaluated during design.

The goal of all SBW treatment processes is to produce a solid waste product from the mostly liquid SBW. For most unit operations of most processes, solids in the feed are like 'inerts" – that is, their composition will have little or no effect on the design. If the solids are chemically changed in the process, such as in a glass melter, their composition becomes more important to the design. Thus, even though there are significant uncertainties in the solids composition, these uncertainties are expected to have a negligible effect on most unit operations of a treatment process. The primary exemption to this statement would be a glass melter.

The variation in tank solids composition is detailed in Section 3.2. The analysis of the July 2003 Tank WM-187 samples provides one estimate of the uncertainties in these compositions. Table 33 shows a comparison between the results of analysis of this sample and the expected composition, based on analysis of samples from samples of Tanks WM-182 and WM-183, the source of the solids in WM-187 at the time it was sampled.

Table 33. Comparison of WM-187 solids composition to source tank solids composition.

	2:1 blend WM-183:WM-182	**WM-187-1**	**Ratio** WM-187/blend	**Ratio** WM-187/182	**Ratio** WM-187/WM-183
	Wt %	Wt %			
Al^{+3}	1.11	1.06	0.95	0.85	1.01
Ca^{+2}	0.07	0.06	0.81	0.47	1.27
Cl^{-}	0.14	1.44	10.22	7.61	12.33
Cr^{+3}	0.04	0.03	0.72	0.63	0.77
F^{-}	0.85	0.26	0.30	0.16	0.58
Fe^{+3}	1.48	2.01	1.36	4.73	1.00
Mo^{+6}	0.15	0.09	0.60	0.31	1.13
NO_3^{-}	0.00	5.65			
PO_4^{-3}	13.83	22.18	1.60	2.72	1.33
K^{+}	0.78	0.35	0.45	0.71	0.38
Si^{+4}	4.86	10.47	2.15	2.00	2.24
Na^{+}	0.89	0.06	0.07	0.03	0.16
SO_4^{-2}	2.16	1.84	0.85	0.50	1.33
Sn^{+4}	0.29	0.42	1.44	0.87	2.17
Ti^{+4}	0.09	0.14	1.62	1.84	1.52
Zr^{+4}	7.10	6.65	0.94	0.55	1.44
O^{-2}	6.42	9.63	1.50	1.00	2.00
H2O	9.08	15.57	1.71	2.31	1.52
Total	49.37	77.91			
	Ci/kg	**Ci/kg**			
Sr-90	7.3E-03	1.7E-02	2.37	2.05	2.58
Sb-125	1.2E-02	6.7E-03	0.57	0.21	4.03
Cs-134	9.2E-04	5.1E-04	0.56	0.22	2.35
Cs-137	5.9E-01	1.2E+00	1.99	3.42	1.64
Eu-154	4.9E-04	2.8E-04	0.58	0.39	0.76
U-234	3.8E-06	3.5E-06	0.93	0.64	1.20
U-235	1.8E-07	5.3E-07	3.01	2.34	3.51
U-238	3.2E-08	1.3E-07	4.05	5.76	3.52
Np-237	1.7E-06	1.7E-06	0.97	1.00	0.95
Pu-238	6.7E-03	9.9E-03	1.47	0.69	3.37
Pu-239	1.1E-03	2.3E-03	2.14	1.92	2.26
Am-241	3.4E-04	3.0E-04	0.88	0.46	1.60

If all samples were perfectly representative of well-mixed solids in the respective tanks, and no composition change occurred washing solids from WM-182 and WM-183 to WM-187, all ratios in the "WM-187/Blend" column would equal 1. The table shows ratios for a few species close to 1, but most are not. This implies nonrepresentative samples and/or composition changes due to precipitation or dissolution during or after solids transfer. Table 33 also shows ratios of the WM-187 sample concentration to those of solids from the two source tanks, WM-182 and WM-183. Comparing the three columns of ratios, it appears that tank WM-187 solids are closer in composition to WM-183 or the blend than they are to WM-182. This implies that some blending of the solids in WM-187 may have taken place.

Comparing results from analysis of the most recent Tank WM-187 sample to a predicted composition leads to similar conclusions. Some species, such as Hg and PO_4 are close to the predicted concentrations, while others are either significantly higher (Si, Cl, NO_3, O) or lower (Ca, K, Na, Fe, Zr, F, SO_4).

While changes in Tank Farm management could affect waste composition, any change from this time forward will have a minimal effect because one tank is now full, another is nearly full, and the third should be nearly full by the end of 2004. Thus, there is neither time nor tank space to make much of a change. Should the waste generated by Tank WM-180 evaporation unexpectedly exceed the capacity of Tank WM-187, another tank would need to be used to store the excess. Because present projections show WM-187 with about 15,000 gallons of spare capacity at the end of 2005, the risk of exceeding its capacity is low.

Tables 34 and 35 provide additional estimates of the uncertainty in SBW sample analyses. Table 34 compares results of liquid analyses for two samples from the same tank (WM-180), one sample taken in 1993 and the second in 2000. Approximately 278,900 gallons of waste were in WM-180 at the time of sampling in 1993. Later, about 400 gallons of waste and 2000 gallons of water were added, 3400 gallons were transferred out of WM-180 in 1997, and 2600 gallons were transferred to the NWCF for sampling in 2000. Thus, at most, 1% of the difference between the two analyses can be accounted for by additions to the tank; the remainder of the difference provides an estimate of the uncertainty in the composition. While the differences between the two sets of analyses are within ~10% for most species, larger differences are seen for a few species.

Table 35 provides an estimate of the how uncertainty in the solids composition affects the total waste composition in a tank. The table compares concentrations of the total waste in WM-189 based on two separate analyses of solids. As mentioned in Section 2.3, the sample of solids from Tank WM-189 was dried with interstitial liquid, the undissolved solids accounting for only about 22% of the total solids. Table 35 compares the total tank waste composition calculated assuming the solids have the composition of the WM-188 solids to the composition using the WM-189 undissolved solids/dissolved solids analyses. Differences are within about 10% for all major species except fluoride and phosphate.

Table 34. Comparison of analyses of WM-180 samples.

	1993 Mol/liter	**2000** Mol/liter	**Ratio** 2000/1993
H^+	1.14E+00	1.10E+00	0.96
Al^{+3}	5.90E-01	6.63E-01	1.12
Ba^{+2}	5.10E-05	5.58E-05	1.09
B^{+3}	1.02E-02	1.23E-02	1.20
Cd^{+2}	7.73E-04	7.54E-04	0.98
Ca^{+2}	3.39E-02	4.72E-02	1.39
Cl^-	3.11E-02	3.00E-02	0.96
Cr^{+3}	3.29E-03	3.35E-03	1.02
F^-	4.18E-02	4.74E-02	1.13
Fe^{+3}	1.75E-02	2.17E-02	1.24
Pb^{+2}	1.23E-03	1.31E-03	1.06
Hg^{+2}	9.89E-04	2.02E-03	2.04
Ni^{+2}	1.48E-03	1.47E-03	0.99
NO_3^-	4.56E+00	5.01E+00	1.10
K^+	1.83E-01	1.96E-01	1.07
Se^{+2}	1.04E-05	1.46E-04	14.0
Ag^+	4.43E-06	5.29E-06	1.19
Na^+	2.00E+00	2.06E+00	1.03
SO_4^{-2}	4.28E-02	6.98E-02	1.63

Table 35. Comparison of two methods of calculating the composition of WM-189 waste.

Concentration based on WM-189 solids analyses divided by concentration based on WM-188 solids analyses

	Ratio		**Ratio**
H^+	1.00	Sr-90	0.93
Al^{+3}	1.04	Cs-137	0.90
Ca^{+2}	1.04	U-238	1.08
Cl^-	0.92	Np-237	0.95
F^-	0.74	Pu-238	0.89
Fe^{+3}	1.04	Pu-239	0.88
Hg^{+2}	0.94	Am-241	1.09
NO_3^-	0.98		
PO_4^{-3}	0.31		
K^+	1.06		
Na^+	1.09		
SO_4^{-2}	1.01		
Zr^{+4}	1.09		

3.4 Solids Co-processing Scenarios

Consolidation of SBW into Tanks WM-187, WM-188, and WM-189 requires redefining a scenario to more evenly distribute tank solids within the entire SBW inventory from what has been presented in previous reports (such as Rev. 3 of this report or Wood 2002). For treatment alternatives that co-process undissolved solids with SBW liquid, solids distribution is needed to (1) reduce the concentration of undissolved solids from that in the initial waste in WM-187 in order to avoid settling of solids in lines during transfer of waste to treatment,[h] (2) to minimize effects of the solids on the performance of the treatment process, due both to physical and chemical differences in the solids and liquids, and (3) to potentially simplify waste qualification by having a more narrow feed composition band.

One option is to install mixing pumps only in Tank WM-187, and design a new receiving tank or tanks to blend waste received from different Tank Farm Tanks. Waste would be transferred from WM-187 and either WM-188 or WM-189 to the new receiving tank, mixed in the new tank and then fed to the treatment process. This scenario has the advantages of the using the minimum number of mix pumps and not using Tank WM-190. However, this scenario would require frequent, short-duration transfers of waste or a very large new tank. Another major disadvantage of this scheme is that it is likely that samples would need to be taken and analyzed each time the receiving tank was filled, for the purpose of waste qualification. In other scenarios, sampling is limited to samples from 300,000-gal tanks, greatly reducing the number of samples. A third disadvantage is that this scenario would require the transfer of Tank WM-187 waste with high solids to the treatment facility, and may result in solids settling if the existing jet transfer and transfer lines are used. While a cost /benefit analysis has not been performed for this scenario, the negative impact on waste qualification and potential for solids settling is likely to outweigh the benefits of this scheme.

A second option would be to use Tank WM-190 as the feed blend tank. A “batch” of feed would be made up in Tank WM-190 by transferring waste from WM-187, WM-188, WM-189, and the NGLW tanks. Feed to SBW treatment would then consist of three batches of nearly identical composition (the average of all SBW plus NGLW) plus a smaller final batch containing heel solids from WM-188 and WM-189. This scenario is shown in Table 36.

For this option, mixing pumps would be installed in Tanks WM-187 and WM-190. Installation of pumps in WM-190 could be done while the tank is empty and essentially free from contamination. The first two feed batches would be made up of equal amounts of waste from WM-187, WM-188, WM-189, and the NGLW tanks. For the second batch, the NGLW tanks would be emptied to allow for a later transfer of waste from WM-188. This waste would be held in the NGLW tanks for later blending with the heels flushed from WM-188 and WM-189. The third feed batch would be made up of waste from WM-187, WM-188, and WM-189, and would reduce the waste to heel level in each of these tanks. These heels would be flushed to WM-190, and then the flush water evaporated. The evaporator concentrate would be added back to WM-190 after emptying the tank to heel level, and the waste temporarily stored in the NGLW tanks would also be added to WM-190 to complete the make up of the fourth and final treatment feed batch. Additional tanks, such as WL-101 and/or WL-102 may be needed to store the evaporator concentrate if WM-100, WM-101, and WM-102 reach their capacities. After Batch 4 is processed, Tank WM-190 would be flushed to the NGLW tanks.

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[h] Or alternatively, to avoid the expense of a new transfer system from the Tank Farm to the treatment facility

Table 36. Tank mix scenario using Tank WM-190 for blending.

	WM-187	WM-188	WM-189	NGLW Tanks	WM-190	Waste to Treatment
Initial waste volume, gallons	279,608	284,381	279,800	72,180	0	
Initial undissolved solids, g/liter	99.4	4.6	9.4	4.1		
Batch 1 transfers, gallons	-92,000	-64,000	-85,000	-36,090	285,402	299,673
undissolved solids, g/liter						31.1
Batch 2 transfers, gallons	-92,000	-64,000	-85,000	-36,090	285,402	299,673
undissolved solids, g/liter						31.1
Batch 3 transfers, gallons	-92,000	-95,000	-90,000		285,310	299,576
undissolved solids, g/liter						31.2
Transfer to NGLW tanks, gallons		-53,000		54,590		
Heel, gallons	3,608	8,381	19,800			
Flushing Heel to WM-190, gallons	-3,608	-8,381	-19,800		181,789	
Evaporation of WM-190, gallons					-180,000	
Addition of concentrated waste					31,789	
Batch 4 transfer, gallons				-54,590	88,017	92,418
undissolved solids, g/liter						41.1
Total waste to treatment, gallons						**991,338**

A second scenario would use WM-189 as the feed blend tank. Mixing pumps would be installed in Tanks WM-187 and WM-189. An initial transfer of about 141,000 gallons of waste would be made from WM-189 to WM-190, to provide capacity in Tank WM-189 to receive higher solids content waste from WM-187. Four sequential feed batches would be made up in Tank WM-189, the first two of waste from WM-189, WM-187, and NGLW, and the second two of waste from WM-188, WM-187, and NGLW. While Batch 4 is being processed in the treatment facility, Tank WM-188 could be flushed to Tank WM-187. Most of the solids initially in Tank WM-189 will have been processed with Batches 1-4, and thus less SBW would need to be saved for treating the final heel solids. This waste could initially be held in WM-190 and then transferred to one of the NGLW tanks, or transferred directly to one of the NGLW tanks after it has been emptied. Table 37 shows about 10,000 gallons from WM-189 and 16,000 gallons from WM-188 for this final batch, but the scenario could be adjusted to have all the waste come from just one of these tanks. When emptied of waste, the heel in WM-190 can be flushed to WM-187. Then upon completion of treatment of Batch 4, the heel in WM-189 can also be flushed to WM-187. The dilute liquid in Tank WM-187 would be evaporated, with the evaporator concentrate stored temporarily in the NGLW tanks. When the level in Tank WM-187 was brought down to the solids layer, evaporation of the tank would be stopped and the concentrate from the NGLW tanks added to make up the fifth and final treatment batch. Tank and feed volumes for this scenario are shown in Table 37.

Table 37. Tank mix scenario using Tank WM-189 for blending.

	WM-187	WM-188	WM-189	NGLW Tanks	WM-190	Waste to Treatment
Initial waste volume, gallons	279,608	284,381	279,800	72,180	0	
Initial undissolved solids, g/liter	99.4	4.6	9.4	4.1		
Tank transfer, gallons			-140,800		145,024	
Batch 1, gallons	-64,000		-220,506	-18,045		231,532
undissolved solids, g/liter						33.2
Batch 2, gallons	-64,000		-221,521	-18,045	-133,024	232,597
undissolved solids, g/liter						32.8
Transfer, gallons		-16000			16,480	
Batch 3, gallons	-74,000	-130,000	-228,706	-18,045		240,142
undissolved solids, g/liter						31.0
Batch 4, gallons	-74,000	-130,000	-228,706	-18,045		240,142
undissolved solids, g/liter			31.0			31.0
Final heel	3,608	8,381	3,000		28,480	
Flushing Heel to WM-187	193,469					
Evaporation of WM-187	-173,500					
Batch 5 transfer				43,469		45,642
undissolved solids, g/liter						33.4
Total waste to treatment, gallons			**942,909**			**990,054**

Other schemes are certainly possible. For example, four feed batches rather than three could be prepared in Tank WM-190, which may improve the mix pump performance by reducing the height of waste in a tank. A summary of advantages and disadvantages of the two schemes is given below:

Advantages	WM-190 Blend Tank Scenario	WM-189 Blend Tank Scenario
Mix pumps installed in only two tanks	x	x
Mix pumps installed in an empty, nonrad tank	x	
Minimum treatment facility feed batches	x	
Most homogeneous blending of tank wastes	x	
Possible better mixing due to smaller feed batches		x
Uniform undissolved solids concentration in all feed batches		x
Greater flexibility to accommodate uncertainty in NGLW volume		x
Flushing of at least one tank can occur during SBW treatment		x
Minimal use of WM-190, allowing it to be availableas a spare for part of the time		x
Does not require use of tanks other than the four TF tanks and the 3 NGLW tanks		x

Blended waste compositions based on the WM-189 Blend Tank Scenario are shown in Table 38.

Table 38. Tank blend compositions for WM-189 Blend Scenario.

	Batch 1	**Batch 2**	**Batch 3**	**Batch 4**	**Batch 5**
Gallons	231,532	232,597	240,142	240,142	45,642
SG	1.25	1.21	1.22	1.22	1.24
	mol/liter	**mol/liter**	**mol/liter**	**mol/liter**	**mol/liter**
H+	2.25E+00	2.15E+00	2.03E+00	2.03E+00	2.43E+00
Al^{+3}	6.40E-01	6.16E-01	6.03E-01	6.03E-01	6.50E-01
Am^{+4}	9.46E-08	9.15E-08	9.10E-08	9.10E-08	8.34E-08
Sb^{+5}	1.56E-05	1.52E-05	1.40E-05	1.40E-05	8.82E-06
As^{+5}	1.62E-04	1.61E-04	1.79E-04	1.79E-04	5.26E-05
Ba^{+2}	7.02E-05	6.81E-05	8.21E-05	8.21E-05	7.07E-05
Be^{+2}	1.84E-05	1.77E-05	1.61E-05	1.61E-05	1.86E-05
B^{+3}	1.69E-02	1.62E-02	1.64E-02	1.64E-02	1.97E-02
Br^{-}	2.65E-07	2.55E-07	3.22E-07	3.22E-07	3.47E-07
Cd^{+2}	2.59E-03	2.46E-03	2.11E-03	2.11E-03	3.10E-03
Ca^{+2}	5.85E-02	5.60E-02	5.22E-02	5.22E-02	6.26E-02
Ce^{+4}	5.21E-05	5.08E-05	5.20E-05	5.20E-05	3.82E-05
Cs^{+}	4.27E-05	4.16E-05	4.78E-05	4.78E-05	3.56E-05
Cl^{-}	2.54E-02	2.47E-02	3.02E-02	3.02E-02	2.66E-02
Cr^{+3}	5.07E-03	4.88E-03	4.70E-03	4.70E-03	5.12E-03
Co^{+2}	4.04E-05	3.87E-05	3.94E-05	3.94E-05	4.43E-05
Cu^{+2}	8.08E-04	7.76E-04	6.82E-04	6.82E-04	7.87E-04
Eu^{+3}	4.40E-07	4.23E-07	5.34E-07	5.34E-07	5.75E-07
F^{-}	3.13E-02	3.08E-02	4.47E-02	4.47E-02	2.91E-02
Gd^{+3}	1.49E-04	1.44E-04	1.74E-04	1.74E-04	1.58E-04
Ge^{+4}	7.64E-09	7.34E-09	9.27E-09	9.27E-09	1.00E-08
In^{+3}	1.21E-06	1.17E-06	1.47E-06	1.47E-06	1.58E-06
I^{-}	3.00E-06	2.91E-06	3.56E-06	3.56E-06	3.11E-06
Fe^{+3}	2.70E-02	2.60E-02	2.54E-02	2.54E-02	2.55E-02
La^{+3}	7.99E-06	7.67E-06	9.69E-06	9.69E-06	1.04E-05
Pb^{+2}	1.08E-03	1.04E-03	9.96E-04	9.96E-04	1.03E-03
Li^{+}	4.51E-04	4.37E-04	4.29E-04	4.29E-04	3.74E-04
Mg^{+2}	1.89E-02	1.82E-02	2.02E-02	2.02E-02	2.20E-02
Mn^{+4}	1.80E-02	1.73E-02	1.59E-02	1.59E-02	1.64E-02
Hg^{+2}	4.97E-03	4.75E-03	5.07E-03	5.07E-03	6.04E-03
Mo^{+6}	3.47E-04	3.36E-04	3.33E-04	3.33E-04	2.92E-04
Nd^{+3}	2.58E-05	2.47E-05	3.12E-05	3.12E-05	3.37E-05

Table 38. (Continued.)

	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
	mol/liter	**mol/liter**	**mol/liter**	**mol/liter**	**mol/liter**
Np^{+4}	1.50E-05	1.44E-05	1.81E-05	1.81E-05	1.93E-05
Ni^{+2}	1.97E-03	1.89E-03	2.01E-03	2.01E-03	2.30E-03
Nb^{+5}	7.91E-04	7.71E-04	6.19E-04	6.19E-04	4.04E-04
NO_3^-	6.51E+00	6.26E+00	5.87E+00	5.87E+00	6.43E+00
Pd^{+4}	6.47E-04	6.43E-04	9.02E-04	9.02E-04	4.02E-04
PO_4^{-3}	1.05E-01	1.04E-01	1.07E-01	1.07E-01	4.13E-02
Pu^{+4}	9.03E-06	8.87E-06	1.04E-05	1.04E-05	5.93E-06
K^+	2.35E-01	2.27E-01	2.03E-01	2.03E-01	1.86E-01
Pr^{+4}	7.26E-06	6.98E-06	8.81E-06	8.81E-06	9.50E-06
Pm^{+3}	6.21E-08	6.18E-08	6.93E-08	6.93E-08	1.89E-08
Rh^{+4}	3.13E-06	3.01E-06	3.80E-06	3.80E-06	4.10E-06
Rb^+	4.82E-06	4.63E-06	5.85E-06	5.85E-06	6.31E-06
Ru^{+3}	4.89E-04	4.78E-04	4.77E-04	4.77E-04	3.02E-04
Sm^{+3}	4.80E-06	4.62E-06	5.82E-06	5.82E-06	6.25E-06
Se^{+4}	4.06E-05	4.01E-05	4.25E-05	4.25E-05	1.66E-05
Si^{+4}	1.80E-01	1.79E-01	1.91E-01	1.91E-01	6.36E-02
Ag^+	2.69E-04	2.67E-04	2.91E-04	2.91E-04	9.10E-05
Na^+	2.00E+00	1.93E+00	1.67E+00	1.67E+00	1.65E+00
Sr^{+2}	1.29E-04	1.25E-04	1.02E-04	1.02E-04	1.08E-04
SO_4^{-2}	8.57E-02	8.21E-02	4.46E-02	4.46E-02	6.06E-02
Tc^{+7}	1.54E-05	1.51E-05	2.04E-05	2.04E-05	1.33E-05
Te^{+4}	5.19E-06	4.95E-06	3.51E-06	3.51E-06	4.95E-06
Tb^{+4}	1.84E-09	1.77E-09	2.23E-09	2.23E-09	2.40E-09
Tl^{+3}	1.45E-05	1.43E-05	1.49E-05	1.49E-05	6.40E-06
Th^{+4}	2.27E-05	2.16E-05	2.00E-05	2.00E-05	2.87E-05
Sn^{+4}	1.15E-03	1.13E-03	1.17E-03	1.17E-03	4.72E-04
Ti^{+4}	6.64E-04	6.54E-04	6.70E-04	6.70E-04	2.96E-04
U^{+4}	5.60E-04	5.38E-04	4.06E-04	4.06E-04	4.78E-04
V^{+5}	2.85E-04	2.82E-04	3.21E-04	3.21E-04	1.06E-04
Y^{+3}	5.95E-06	5.72E-06	7.22E-06	7.22E-06	7.79E-06
Zn^{+2}	1.01E-03	9.75E-04	9.25E-04	9.25E-04	9.47E-04
Zr^{+4}	1.82E-02	1.80E-02	1.99E-02	1.99E-02	9.23E-03
O-2	2.82E-01	2.80E-01	2.98E-01	2.98E-01	9.89E-02
H2O	4.10E+01	3.95E+01	4.18E+01	4.18E+01	4.16E+01

Table 38. (Continued.)

	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
	g/liter	**g/liter**	**g/liter**	**g/liter**	**g/liter**
TOC	8.69E-01	8.48E-01	7.47E-01	7.47E-01	4.43E-01
UDS	3.15E+01	3.11E+01	3.14E+01	3.14E+01	1.29E+01
	Ci/kg	**Ci/kg**	**Ci/kg**	**Ci/kg**	**Ci/kg**
	Jan-03	**Jan-03**	**Jan-03**	**Jan-03**	**Jan-03**
Ra-226	6.94E-12	6.67E-12	8.41E-12	8.41E-12	9.01E-12
Ac-227	3.27E-11	3.14E-11	3.96E-11	3.96E-11	4.24E-11
Th-230	1.09E-09	1.06E-09	1.28E-09	1.28E-09	1.03E-09
Th-231	1.78E-08	1.71E-08	2.15E-08	2.15E-08	2.31E-08
Th-232	6.00E-16	5.77E-16	7.27E-16	7.27E-16	7.79E-16
Th-234	1.75E-08	1.69E-08	2.13E-08	2.13E-08	2.28E-08
Pa-231	7.57E-11	7.28E-11	9.18E-11	9.18E-11	9.83E-11
Pa-233	2.48E-06	2.39E-06	3.01E-06	3.01E-06	3.22E-06
Pa-234m	1.75E-08	1.69E-08	2.13E-08	2.13E-08	2.28E-08
U-232	2.51E-09	2.44E-09	3.03E-09	3.03E-09	2.54E-09
U-233	8.19E-11	7.92E-11	1.01E-10	1.01E-10	9.63E-11
U-234	1.58E-06	1.53E-06	1.30E-06	1.30E-06	1.37E-06
U-235	6.27E-08	6.06E-08	8.75E-08	8.75E-08	8.29E-08
U-236	8.50E-08	8.23E-08	6.93E-08	6.93E-08	6.14E-08
U-237	5.45E-09	5.24E-09	6.91E-09	6.91E-09	7.38E-09
U-238	3.80E-08	3.65E-08	2.17E-08	2.17E-08	2.48E-08
Np-237	1.99E-06	1.90E-06	2.47E-06	2.47E-06	3.08E-06
Np-238	4.27E-07	4.25E-07	4.76E-07	4.76E-07	1.23E-07
Np-239	8.45E-08	8.02E-08	1.30E-07	1.30E-07	1.64E-07
Pu-236	3.49E-09	3.39E-09	4.19E-09	4.19E-09	3.49E-09
Pu-238	8.80E-04	8.63E-04	1.05E-03	1.05E-03	6.45E-04
Pu-239	1.23E-04	1.21E-04	1.46E-04	1.46E-04	7.97E-05
Pu-240	1.31E-05	1.27E-05	1.57E-05	1.57E-05	1.29E-05
Pu-241	7.01E-04	6.86E-04	7.27E-04	7.27E-04	4.74E-04
Pu-242	1.01E-08	9.86E-09	1.23E-08	1.23E-08	1.02E-08
Pu-244	7.63E-16	7.39E-16	4.16E-16	4.16E-16	3.40E-16
Am-241	7.79E-05	7.53E-05	7.48E-05	7.48E-05	6.85E-05
Am-242m	1.24E-08	1.19E-08	1.67E-08	1.67E-08	1.82E-08
Am-242	1.24E-08	1.19E-08	1.66E-08	1.66E-08	1.81E-08
Am-243	2.07E-08	1.99E-08	2.69E-08	2.69E-08	2.67E-08
Cm-242	2.38E-08	2.28E-08	3.20E-08	3.20E-08	3.55E-08

Table 38. (Continued.)

	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
	Ci/kg	Ci/kg	Ci/kg	Ci/kg	Ci/kg
	Jan-03	Jan-03	Jan-03	Jan-03	Jan-03
Cm-243	3.68E-08	3.58E-08	4.32E-08	4.32E-08	3.50E-08
Cm-244	2.14E-06	2.09E-06	2.26E-06	2.26E-06	1.32E-06
Cm-245	4.43E-10	4.32E-10	5.17E-10	5.17E-10	3.84E-10
Cm-246	2.90E-11	2.83E-11	3.38E-11	3.38E-11	2.52E-11
H-3	1.27E-05	1.24E-05	1.67E-05	1.67E-05	1.37E-05
Be-10	2.54E-12	2.44E-12	3.08E-12	3.08E-12	3.30E-12
C-14	1.47E-10	1.43E-10	1.71E-10	1.71E-10	1.48E-10
Se-79	6.67E-07	6.45E-07	6.96E-07	6.96E-07	6.56E-07
Rb-87	2.48E-11	2.39E-11	3.01E-11	3.01E-11	3.22E-11
Sr-90	3.39E-02	3.26E-02	4.01E-02	4.01E-02	4.26E-02
Y-90	3.39E-02	3.26E-02	4.01E-02	4.01E-02	4.26E-02
Zr-93	1.88E-06	1.80E-06	2.28E-06	2.28E-06	2.44E-06
Tc-98	2.11E-12	2.02E-12	2.57E-12	2.57E-12	2.84E-12
Tc-99	2.59E-05	2.54E-05	3.43E-05	3.43E-05	2.22E-05
Ru-106	1.14E-06	1.11E-06	1.33E-06	1.33E-06	1.15E-06
Rh-102	7.30E-10	7.02E-10	8.85E-10	8.85E-10	9.48E-10
Rh-106	1.14E-06	1.11E-06	1.33E-06	1.33E-06	1.15E-06
Pd-107	1.40E-08	1.35E-08	1.70E-08	1.70E-08	1.82E-08
Cd-113m	2.81E-06	2.70E-06	3.41E-06	3.41E-06	3.65E-06
In-115	8.53E-17	8.20E-17	1.03E-16	1.03E-16	1.11E-16
Sn-121m	5.67E-08	5.44E-08	6.87E-08	6.87E-08	7.35E-08
Sn-126	5.02E-07	4.87E-07	5.84E-07	5.84E-07	5.06E-07
Sb-125	2.41E-04	2.40E-04	2.67E-04	2.67E-04	8.54E-05
Sb-126m	3.48E-07	3.34E-07	4.22E-07	4.22E-07	4.52E-07
Sb-126	4.87E-08	4.68E-08	5.91E-08	5.91E-08	6.33E-08
Te-123	3.25E-19	3.12E-19	3.94E-19	3.94E-19	4.21E-19
Te-125m	2.67E-06	2.56E-06	3.23E-06	3.23E-06	3.46E-06
I-129	6.40E-08	6.20E-08	7.45E-08	7.45E-08	6.53E-08
Cs-134	4.91E-05	4.76E-05	6.80E-05	6.80E-05	6.00E-05
Cs-135	1.02E-06	9.84E-07	1.19E-06	1.19E-06	1.05E-06
Cs-137	5.86E-02	5.68E-02	6.85E-02	6.85E-02	6.10E-02
Ba-137m	5.54E-02	5.37E-02	6.48E-02	6.48E-02	5.77E-02
La-138	1.62E-16	1.55E-16	1.96E-16	1.96E-16	2.10E-16

Table 38. (Continued.)

	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
	Ci/kg	Ci/kg	Ci/kg	Ci/kg	Ci/kg
	Jan-03	Jan-03	Jan-03	Jan-03	Jan-03
Ce-142	2.53E-11	2.43E-11	3.07E-11	3.07E-11	3.29E-11
Ce-144	7.70E-07	7.47E-07	8.96E-07	8.96E-07	7.73E-07
Pr-144	5.56E-07	5.34E-07	6.58E-07	6.58E-07	7.12E-07
Nd-144	1.36E-15	1.31E-15	1.65E-15	1.65E-15	1.77E-15
Pm-146	4.31E-08	4.14E-08	5.23E-08	5.23E-08	5.60E-08
Pm-147	2.08E-04	2.01E-04	2.42E-04	2.42E-04	2.09E-04
Sm-146	2.34E-13	2.25E-13	2.83E-13	2.83E-13	3.03E-13
Sm-147	6.24E-12	6.00E-12	7.56E-12	7.56E-12	8.10E-12
Sm-148	3.21E-17	3.08E-17	3.89E-17	3.89E-17	4.16E-17
Sm-149	2.85E-18	2.74E-18	3.45E-18	3.45E-18	3.70E-18
Sm-151	4.11E-04	3.98E-04	4.78E-04	4.78E-04	4.13E-04
Eu-150	1.22E-11	1.17E-11	1.48E-11	1.48E-11	1.58E-11
Eu-152	2.45E-06	2.36E-06	2.91E-06	2.91E-06	2.89E-06
Eu-154	1.51E-04	1.45E-04	1.82E-04	1.82E-04	2.02E-04
Eu-155	1.58E-04	1.52E-04	1.87E-04	1.87E-04	1.87E-04
Gd-152	1.20E-18	1.16E-18	1.46E-18	1.46E-18	1.56E-18
Ho-166m	3.90E-11	3.75E-11	4.73E-11	4.73E-11	5.06E-11
Co-60	2.81E-05	2.69E-05	3.85E-05	3.85E-05	4.40E-05
Ni-63	4.01E-05	3.90E-05	4.86E-05	4.86E-05	3.99E-05

3.5 Solids & Slurry Properties

Poloski (2000b) reports that the particle density of air-dried solids from the WM-183 LDUA sample was measured to be 1.88 g/ml. Using measurements of the sludge sample mass, volume and percent water for the same tank sample, a solids particle density of 1.98 g/ml can be derived. These values are commonly rounded to a bulk density of 2.0 g/ml for dried tank solids.

The measured bulk density of solids from several tanks is shown below:

	g/ml
WM-181	0.786
WM-188	0.838
WM-187-1	0.459
WM-187-3	0.421

Particle size distributions (PSD) have been reported for WM-180 solids (Christian 2001), WM-182 and WM-183 solids (Poloski 2000a), WM-189 solids (Batcheller 2003), WM-188 solids (Johnson 2003a), WM-181 solids (Johnson 2003b), and were recently measured for WM-187 solids from the most recent Tank WM-187 sample. The WM-180 solid particles were normally distributed between 2 and 65 µm, with the center of the distribution at 10 µm (Christian 2001). PSDs for WM-182 and WM-183 sonicated solids show median particle sizes of 8 µm and 12 µm respectively. Without sonification, the WM-182 and WM-183 solids size distributions are shifted to larger particle sizes (Poloski 2000a). Particle sizes for the WM-189 sludge sample ranged from 0.5 to 100 µm with a peak at approximately 20 µm (Batcheller 2003). WM-188 particles, without sonification, were distributed between 0.5 and 60 µm, with the average size 4 µm (Johnson 2003a). WM-181 particles were distributed between 0.5 and 30 µm, with the average size about 9 µm (Johnson 2003b). A comparison of particle size distribution for solids from different tanks is shown in Figure 4.

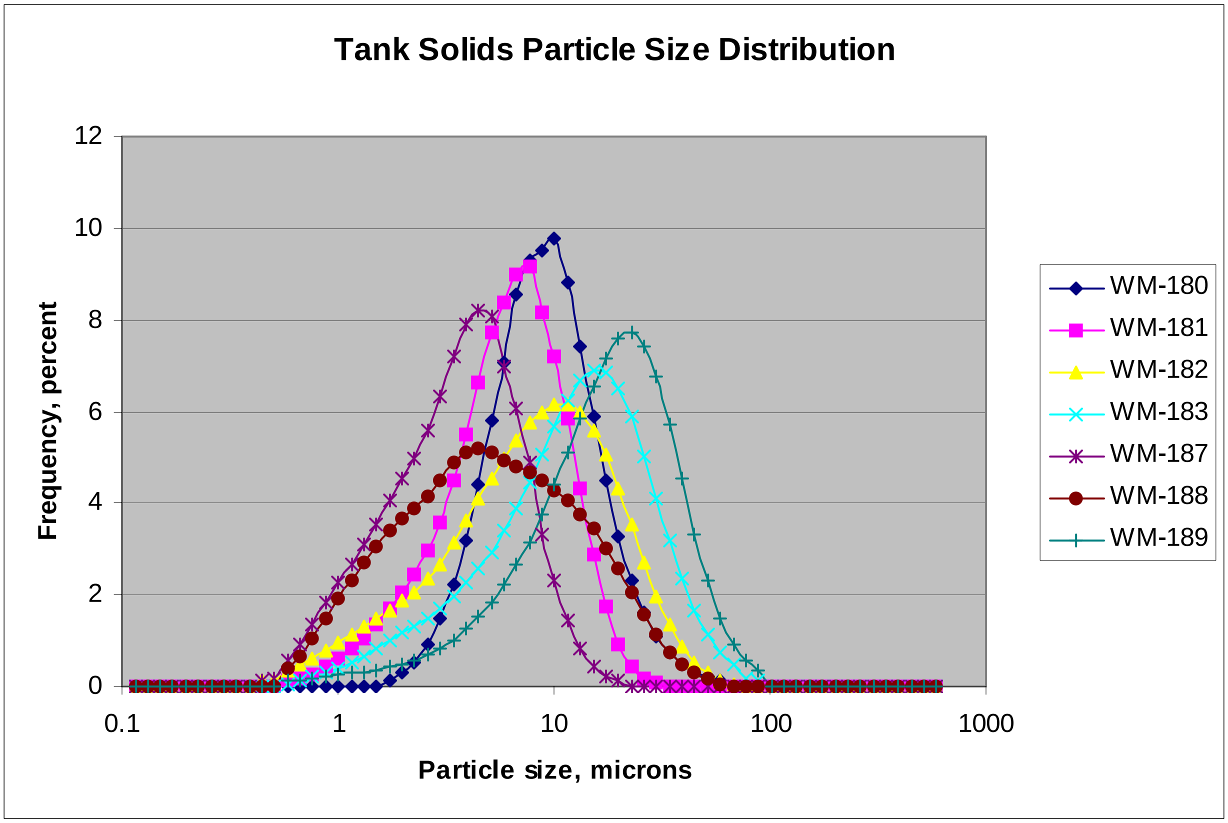

Figure 4. Comparison of solids particle size distribution analyses.

A comparison of settling rate data is shown on Figure 5. Data plotted on Figure 5 is based on measurements of the settled or sludge volume taken at various time intervals.

The solids from the tanks differed in settling. WM-188 and WM-189 both settled by the accumulated sediment method. The solution was cloudy until enough particles agglomerated and then they fell out of solution very rapidly. Once agglomerated, the WM-189 solids settled much faster than the other tanks. Solids in WM-182, WM-183, WM-186, and WM-187 samples all settled by the flocculated sedimentation method. The solution started to clear at the top and slowly cleared to the final volume. Tank WM-181 solids settled completely in about 35 minutes to a volume of 6.5 ml. Then over the next 4 days, this settled volume compressed to 2.1 ml.

The color of the solids differed as well. WM-189 solids were silica like. WM-188 were dark brown-black. Most of the other tanks were a dark gray to black color. A couple samples had a very fine dusting of white solids on top.

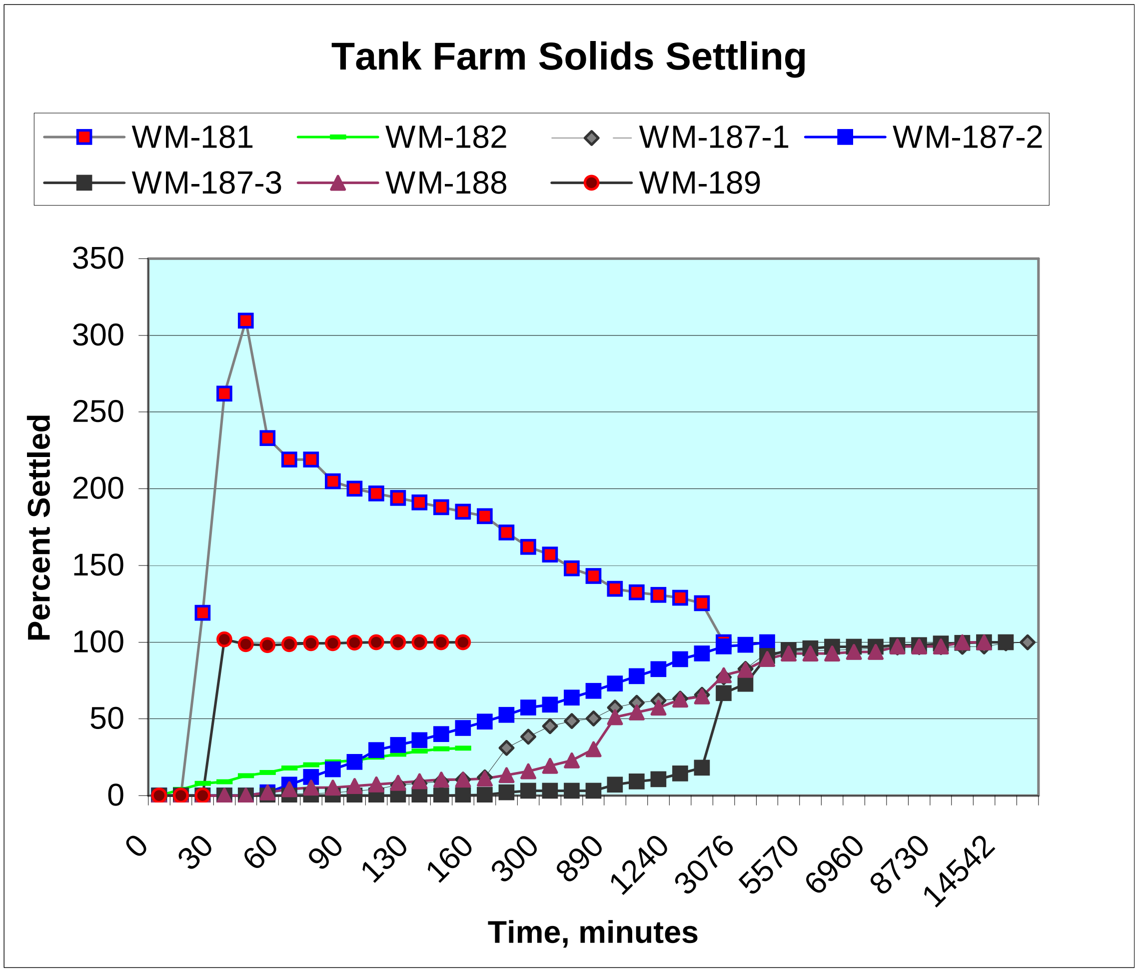

Figure 5. WM-189 and WM-182 relative volume % settled sludge vs. settling time.

Viscosity measurements were made on both the settled WM-182 sludge and the same sludge diluted with an equal volume of demineralized water. Poloski (2001) fit the data to the following flow curves:

Undiluted WM-182 sludge:
Shear stress, dyne/cm^2 = 7.25 x (shear rate, sec^{-1})$^{0.619}$ R^2 = 0.997

Diluted WM-182 sludge:
Shear stress, dyne/cm^2 = 10.25 x (shear rate, sec^{-1})$^{0.218}$ R^2 = 0.988

The viscosity of WM-182 undiluted sludge was approximately 200 cP (Poloski 2001), WM-182 sludge diluted with an equal volume of water about 50 cP (Poloski 2001), WM-189 sludge 3.5 cP (Batcheller 2003), WM-188 sludge 5.5 cP (Johnson 2003a), WM-181 sludge 2.76 cP (Johnson 2003b), and WM-187 sludge 2.71 cP. These viscosities are highly dependent upon the solids content of the sample. Wendt (2004) provides a more detailed analysis of sludge viscosity.

3.6 Liquid Waste Properties

The specific gravity for the liquid waste in Tanks WM-188 is 1.32 (Johnson 2003a) and in Tank WM-189, 1.34 (Batcheller 2003). The specific gravity of the liquid waste in Tank WM-187, when full, is expected to be 1.30.

The viscosity of a liquid sample from Tank WM-188 was measured to be 1.81 cP (Johnson 2003a) and the Tank WM-189 liquid viscosity was measured at 1.94 cP (30.2°C, 60 rpm) (Batcheller 2003). These viscosity values are consistent with measurements of samples from other tanks (Poloski 2001):

WM-180	2.2 cP
WM-181	1.8 cP
WM-182	1.3 cP
WM-186	1.8 cP.

Solids in samples from the above tanks were allowed to settle prior to withdrawing a portion of the liquid for the viscosity measurements. The lower viscosity of WM-182 liquid may be explained by water dilution of the waste prior to sampling.

Batcheller (2003) reports and discusses viscosity data for the WM-189 bottom sample as received. This sample contained about 9 g/liter UDS. At 60 rpm (73.4 sec^{-1} shear rate) the viscosity was 2.6 cP, while at 30 rpm (36.7 sec^{-1} shear rate) the viscosity was 2.1 cP.

Wendt (2004) presents additional data and discussion of the viscosity of tank slurries with different solids fractions.

The thermal conductivity of WM-180 and WM-189 SBW simulants was measured to be 0.547 W/(mK) and 0.525 W/(mK) respectively (Gembarovic 2003). The specific heat for the both simulants was approximately 3.2 W-s/g-K, increasing slightly with temperature (Gembarovic 2003). Gembarovic and Taylor present additional thermal property for SBW simulants as is and neutralized up to a pH of 9-11.

3.7 Organic Species in Liquid Waste

Estimated concentrations for total organics in various tank wastes are shown in Tables 2, 3, 6, 7, 9, 10, and 13-20. This section provides additional information regarding organic species in SBW.

Analysis of samples of Tank WM-189 waste showed 0.092-0.3 mg/liter volatile organic compounds and 0.24-2.0 mg/liter semi-volatile organic compounds (Batcheller 2003). The volatile and semi-volatile compounds amount to only a very small fraction of the TOC in these samples, which was measured to be 513-625 mg/liter. Analysis of a Tank WM-188 sample showed volatile organics present at a concentration of 0.45 mg/liter, semi-volatile organics at a concentration of 0.45 mg/liter, and TOCs at 435 mg/liter (Johnson 2003a).

Other samples of tank wastes have been analyzed for organic compounds.[i] While these samples were from tanks that typically contained reprocessing wastes rather than SBW, the results, in general,

[i] See Appendix B of the *Idaho Hazardous Waste Management Act/Resource Conservation and Recovery Act Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-182 and WM-183*, DOE/ID-10802, November, 2001 and SBW analyses reported in *Analysis of the HLW Calcined During the NWCF Campaign H-4*, LMITCO Internal Report, INEEL/INT-98-00931, September 1998.

may be applicable to SBW. This data is summarized in Table 39. The same analyses reported the following compounds undetected: carbon disulfide, 2-butanone, 1,1,1-trichloroethane, carbon tetrachloride, benzene, 4-methyl-2-pentanone, toluene, and phenol.

Table 39. Summary of organic analyses of TFF samples.

Compound	**Concentration Range** µg/liter	**Validation** Flag[a]	**Tank**	**Reference**
2,4-Dinitrophenol	52-260	J	WM-182	DOE/ID-10802
2-Butanone	9-10	J	WM-182	DOE/ID-10802
Acetone	49-230	E, J	WM-182, WM-183	DOE/ID-10802
Acetone	7-86	J	WM-185, WM-188	INEEL/INT-98-00931
Arochlor-1260	2.5- 2.8	J	WM-183	DOE/ID-10802
Benzene	5-84	J	WM-182	DOE/ID-10802
Bromomethane	98	J	WM-182	DOE/ID-10802
Chloroethane	8	J	WM-182	DOE/ID-10802
Chloromethane	34-530	E, J	WM-182, WM-183	DOE/ID-10802
Ethylbenzene	3-4	J	WM-182	DOE/ID-10802
Xylene (total meta and para)[b]	14	J	WM-182	DOE/ID-10802
N-nitrosodimethylamine	16-31	J	WM-182	DOE/ID-10802
Tributyl phosphate	50	J	WM-182	DOE/ID-10802
Tributyl phosphate	12-58	J, N, B	WM-185, WM-188	INEEL/INT-98-00931
Triphenylester phosphoric acid	61	J, N	WM-188	INEEL/INT-98-00931
Unknown phthalates	1600	J	WM-188	INEEL/INT-98-00931
Unknown semi-volatiles	1100-6500	J, B	WM-185, WM-188	INEEL/INT-98-00931
Organomercury compound	62	J	WM-189	INEEL/INT-98-00931
Pyridine	26-160	E	WM-185, WM-189	INEEL/INT-98-00931
2-Nitropyridine	520	J, N	WM-188	INEEL/INT-98-00931
Dinitrobenzene	30-55	J	WM-185, WM-188	INEEL/INT-98-00931
Chlorinated dinitrobenzene	32	J	WM-188	INEEL/INT-98-00931
Bis (2-ethylhexyl) phthalate	41	J, N	WM-188	INEEL/INT-98-00931
Dibutyl phthalate	200	J, N	WM-189	INEEL/INT-98-00931
Diethyl phthalate	44	J, N	WM-185	INEEL/INT-98-00931
Butylated hydoxytoluene	18	J, N	WM-188	INEEL/INT-98-00931
Diisopropyl ether	36	J, N	WM-185	INEEL/INT-98-00931
Dimethyl sulfone	33	J	WM-185	INEEL/INT-98-00931
Benzylquinoline	500	J	WM-185	INEEL/INT-98-00931

[a] J = estimated; N = tentatively identified; B = compound associated with blank; E = concentration exceeds calibration range.

[b] ortho-xylene was not detected in samples from WM-185 and WM-188

Additional analysis data is available for organic compounds in waste from Tanks WM-189 and WM-185 sampled in 1999 in the NWCF blend and hold cell tanks (Young 2000). Analyses were performed for 68 semivolatile species. No compounds were present at a concentration greater than the detection limit.

Another study evaluated the destruction of 22 different volatile and 21 different semi-volatile organic compounds in simulated SBW (Soelberg 2002). The surrogate waste included nitric acid, aluminum sulfate, calcium chloride, iron sulfate, potassium fluoride, and sodium sulfate. The spiked organic compounds represented a wide range of organic classes and functional groups. Concentrations of the organic species in the simulant were measured at intervals during a 32-day period. Some of the results of this study were as follows:

- Except for chloromethane and bromomethane, levels of all volatile organic compounds (VOCs) decreased over time. The most volatile species rapidly decreased, sometimes to near 0% of the initial spike concentration, even prior to the Day 1 analysis. Lower volatility organic compounds and those with higher water solubility (like acetone, methylisobutylketone, methylene chloride, and carbon disulfide) either decreased more slowly, or showed erratic results. However they nevertheless almost always decreased to 30% or less of the initial spike concentration after 32 days. All VOCs, even those species with slower or erratic depletion rates, would be expected to be highly depleted from the actual SBW that has been held in storage for many years and also exposed to 100^{o}C temperatures during evaporation processes.
- Measured levels of semivolatile organic compounds (SVOCs) decreased more slowly, and in some cases were more erratic, than the VOCs. More reactive SVOCs, like those with double bonds (1,7-octadiene and hexachlorobutadiene) and phenyl groups (cresol, analine, and phenol) were rapidly depleted to a concentration near zero.
- More stable SVOCs like ethers (1,4-dioxane) and water-soluble species like pyridine were depleted more slowly to a relatively stable level, and may not be highly depleted even after long time durations. Levels of some other SVOCs (like nonanoic acid and the nitrophenols) were erratic, and suggest that either (a) in some samples, recovery of these more water-soluble compounds was poor, or (b) these compounds were being formed later in the longer-duration samples.
- The VOC gas chromatography/mass spectrometer scans were evaluated to find any tentatively identified compounds that were not included in the spike compounds and that could have been reaction products of the spiked VOCs. No tentatively identified compounds were detected in appreciable amounts. Even if some reactions of spiked VOCs resulted in reaction products, these products were either (a) volatilized, or (b) too water-soluble to efficiently extract from the aqueous media to be detected.
- Some SVOC tentatively identified compounds were detected in the SVOC scans and suggest that nitration, oxidation, and chlorination reactions occurred in the samples and could occur in the SBW during storage.

As shown in Table 16, oxalic acid, diethanolamine, triethanolamine, and kerosene are part of the decontamination solution used to remove scale from the PEWE evaporator. These compounds or products from the reaction of these compounds with species in SBW are thus likely present in the SBW waste tanks.

Trace amounts of organics may be contained in the tank solids. Analysis of a dried sample of WM-187 solids showed no detectable SVOCs and no detectable polychlorinated biphenyl compounds. Analysis of an undried sample of Tank WM-187 sludge showed a total of less than 1 mg/kg of VOCs. The concentration of 2-butanone in this sample was measured to be 44 μg/kg; concentrations of all other organics detected were flagged as estimated amounts or exceeding the instrument calibration range. These compounds included bromomethane (120 μg/kg), acetone (200 μg/kg), methylene chloride (4.5 μg/kg), 4-methyl-2-pentanone (8 μg/kg), chlorobenzene (3 μg/kg), and 15 unknown compounds.

3.8 NGLW Evaporation & Storage

Tanks WM-100, WM-101, and WM-102 currently contain about 12,000 gallons of waste. Starting in 2005, additional NGLW will be added to these tanks. Based on present projected NGLW generation rates, the three tanks will be filled to their combined maximum capacity of about 55,200 gallons near the end of 2010. If the start of treatment were delayed past 2010, additional storage for NGLW would likely be required. The PEWE bottoms tank, VES-WL-101, has a capacity of 18,400 gallons. The ETS uses the Fluoride Hot Sump Tank in the NWCF, VES-NCC-119, to collect evaporator bottoms. The capacity of this tank is about 5,000 gallons.

The maximum volume of dilute NGLW expected to be generated in any year is 1,084,000 gallons (see Table 12). Concentration of this waste by the PEWE is expected to require about 36 weeks, based on a processing rate of 30,000 gal/week. The ETS has capacity far in excess of what will be required to concentrate NGLW.

4. RECOMMENDATIONS

To reduce uncertainties in the feed compositions to a future SBW treatment facility, the following activities are recommended:

- Review solids analysis methods and procedures and evaluate ways to obtain a tighter material balance when analyzing solids. Based on this evaluation, modify or update procedures for analyzing solids from tank farm tanks.

- Review and evaluate possible ways to obtain more representative solids samples

- Review and evaluate possible ways to more accurately determine the quantity or level of undissolved solids in Tanks WM-187, WM-188 and WM-189.

- After Tank WM-187 is full, sample and analyze waste in this tank. Analyses of both liquid and solids are needed. Potentially, the solids present in the tank could change in composition with the planned addition of concentrated waste to the tank or over time after the tank has been filled. Thus, periodic resampling (every 1-2 years) and analysis of solids in the sample is recommended.

- After Tank WM-188 is full, sample and analyze waste in this tank. Sufficient sample should be obtained to be able to analyze both liquid and solids.

- Resample Tank WM-189 and analyze the solids only using the updated procedure.

- Sample and analyze the NGLW tanks (WM-100, WM-101 and WM-102) annually.

5. REFERENCES

Barnes, C. M., A. L. Olson, D. D. Taylor, 2004, *Sodium-Bearing Waste Treatment Technology Evaluation Report*, INEEL/EXT-04-01692.

Barnes, C. M., S. K. Janikowski, C. B. Millet, 2003, *Feed Composition for the Sodium-Bearing Waste Treatment Process*, INEEL/EXT-2000-01378, Rev. 3, September, 2003.

Barnes, C. M., R. A. Wood, B. H. O'Brien, 2002, "Process Design of SBW Treatment Alternatives," *Engineering Design File EDF-2373*, September 10, 2002.

Batcheller, T. A., D. D. Taylor, V. J. Johnson, 2003, *Characterization of Tank WM-189 Sodium-Bearing Waste at the Idaho Nuclear Technology and Engineering Center*, INEEL/EXT-02-01171 Rev. 1, July 2003.

Christian, J. D., 2001, *Composition and Simulation of Tank WM-180 Sodium-Bearing Waste at the Idaho Nuclear Technology and Engineering Center*, INEEL/EXT-2001-00600, May 2001.

Demmer, R., 2002, *INTEC Waste Minimization Plan*, PLN-225, October 15, 2002.

Garn, T. G., 2001, "Sampling and Characterization of WM-180," *INEEL Interoffice Memorandum TGG-01-01 to J. A. Rindfleisch*, January 11, 2001.

Gembarovic, J., R. E. Taylor, 2003, *Specific Heat and Thermal Conductivity of Two Sodium-Bearing Waste Simulants*, TPRL-3016, September 2003.

Griffith D. L., L. G. Olson, 2003, *Testing an Agitated Thin Film Evaporator For Solidifying a Mixture of Simulated Sodium Bearing Waste and Undissolved Solids (Test Series 2)*, INEEL/EXT-03-01189, November, 2003.

Harbour, J. R., R. F. Schumacher, A. Choi, A. K. Hansen, 2002, *Development of an Initial Simulant for the Idaho Tank Farm Solids*, WSRC-TR-2002-00436, November 11, 2002.

HLW Program Office, 1998, *Analysis of the HLW Calcined During the NWCF Campaign H-4*, LMITCO Internal Report, INEEL/INT-98-00931, September 1998.

Idaho Hazardous Waste Management Act/Resource Conservation and Recovery Act Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-182 and WM-183, 2001, DOE/ID-10802, Appendix B, "Data Summary for Tanks WM-182 and WM-183," November 2001.

Johnson, V. J., R. L. Demmer, T. A. Batcheller, 2003a, *Characterization of Tank WM-188 Sodium-Bearing Waste at the Idaho Nuclear Technology and Engineering Center*, INEEL/EXT-03-00478, June 2003.

Johnson, V. J., R. L. Demmer, 2003b, *Characterization of Tank WM-181 Sodium-Bearing Waste Solids at the Idaho Nuclear Technology and Engineering Center*, INEEL/EXT-03-00979, September, 2003.

Millet, C. B., 2003, "Composition of Tank Farm Waste as of October 2002", *INEEL Interoffice Memorandum Mil-07-02 to J. I. Pruitt*, originally issued December 12, 2002 and reissued with a correction September 25, 2003.

Nenni, J. A., 2004. “ETS Process Parameter and Outlet Stream Predictions for WM-180 Feed,” *INEEL Interoffice Memeorandum to J. P. Law,* JAN-04-04, February 16, 2004.

Nenni, J. A., 2002, “Balance-of-Plant Sample Data Compilation,” *Engineering Design File,* EDF-2506, September 2002.

Packer, E. Bart, 2003, “Preliminary Assessment of Evaporator Technologies for Direct Evaporation of Sodium Bearing Waste,” *Engineering Design File EDF-3443*, April 8, 2003.

Palmer, W. B., C. B. Millet, M. D. Staiger, M. C. Swenson, W. B. McNaught, F. S. Ward, 2000, *INTEC Waste Management Through 2070,* INEEL/EXT-2000-01005, December 2000.

Patterson, M., 1999, *Light Duty Utility Arm Deployment in Tank WM-188*, INEEL/EXT-99-01302, December 1999.

Poloski, A., 2001, “Rheology of the INTEC Tank Farm Closure Surrogate and WM-182 LDUA Sample Dissolution of the WM-182 LDUA Sample in 6M Nitric Acid,” *Engineering Design File EDF-1914,* February 19, 2001.

Poloski, A., 2000a, “Solids Characterization,” *Engineering Design File EDF-TST-001*, September 20, 2000.

Poloski, A. P., 2000b, “INTEC Tank Farm Sludge Density Measurements/Calculations,” *Engineering Design File 15722-040*, July 12, 2000.

Quigley, J. J., 2001, “Material Balance for Vitrification of SBW Liquids and Solids,” *Engineering Design File EDF-1680 Rev. 3*, June 28, 2001.

Soelberg, N., et. al, 2002, “Delisting Data Quality Objectives Project Organic Compound Stability Study,” Revision 1 (unpublished), April 10, 2002.

Staiger, M. D., C. B. Millet, R. A. Nickelson, R. A. Wood, A. Chambers, 2001, “Tank Farm Facility, Tank and Waste Data,*” Engineering Design File EDF-1598*, February 27, 2001.

Swenson, M. C., 2003, “Validation of the Radionuclide Inventory and Mass Balance Used in the INTEC SBW and Tank Farm Residuals WIR Determination Reports,” *Engineering Design File EDF-1920 INEEL/EXT-2001-534*, Revision 5, September 2003.

Swenson, M. C., 2002, “Radiological and Fissile Material Source Term for Tank Farm Undissolved Solids,” *INEEL Interoffice Memorandum to R. P. Durante*, MCS-06-02, November 7, 2002.

Swenson, M. C., 2001, “HLLWE Plugging Problems Associated with WM-186 Waste,” *INEEL Interoffice Correspondence to M. W. Patterson*, MCS-04-01, May 30, 2001.

Swenson, M. C., 1992, *Historical Tank Farm Sample Results*, *INEL Memorandum MCS-27-92 to M. R. Christensen*, December 17, 1992.

Tripp, J. L., 1998, *Supporting Information for the INEEL Liquid Waste Management Plan, Appendix B*, INEEL/EXT-98-00730, July 1998.

Tyson, D. R., 2002, “Validation of the Radionuclide Mass Balance Used in the INTEC SBW WIR Determination Report,” *Engineering Design File EDF-1920*, Revision 4, August 29, 2002.

Young, L. J., N. R. Soelberg, B. H. O'Brien, R. D. Boardman, L. A. Matejka, M. L. Abbott, G. R. Hassel, 2000, *NWCF Calciner Emissions Inventory – Final Report for Test Series 1, 2, and 3*, INEEL/EXT-2000-00114, January, 2000, Part 2, Appendix F.

Wendt, D., 2004, *INTEC SBW Solid Sludge Surrogate Recipe and Validation*, ICP/EXT-04-00415 Rev. 0, June 2004.

Wenzel, D., 2002, "Relative Inventories of Reactor-Produced Species in INTEC Waste Types," *Engineering Design File EDF-CRPD-001*, November 4, 2002.

Wenzel, D. R., 2000, "Calculation of July 1999 Inventories for INTEC Wastes," *INEEL Interoffice Memorandum Wen-27-99 to M. D. Staiger*, originally issued November 7, 1999 and reissued with corrections August, 2000.

Wenzel, D. R., 1999, "Calculation of July 1999 Radionuclide Inventory for Sodium-Bearing Waste," *INEEL Interoffice Correspondence Wen-20-99 to A. L. Olson*, May 18, 1999.

Wenzel, D. R., 1997, "Evaluation of Radionuclide Inventory for Sodium-Bearing Waste," *Engineering Design File EDF-FDO-006/CPP-97080*, November 26, 1997.

Wood, R. A., 2002, "Heel Solids Process Evaluation for the Idaho Tank Farm Project NWCF MACT Upgrade Option," *Engineering Design File EDF-3049*, December 2002.